THREE ESSAYS ON THE IMPACT OF CONFLICT AND DISEASE ON HOUSEHOLD WELFARE IN SIERRA LEONE

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DECLARATION

I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another university for the award of any other degree.

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SUMMARY

This thesis comprises three essays on the impact of conflict and disease on household welfare in Sierra Leone.

In the first essay, we examine the impact of the Sierra Leone civil war on average household expenditure and poverty incidence using data from three rounds of household surveys. The key findings reveal that households located in areas subject to high conflict intensity and a protracted period of occupation by the rebel forces during the war experienced lower per capita expenditure levels and higher poverty rates post-conflict. The adverse welfare impact on households situated in the conflict-affected zones was found to persist almost a decade after the conflict's conclusion.

The second essay investigates the immediate and long-run impact of the Sierra Leone civil war on household inequality measured using selected household expenditure quantiles and the Gini coefficient. The findings reveal that households located in chiefdoms that experienced a protracted length of occupation by the rebel forces had lower per capita expenditure across the unconditional household welfare distribution, but much stronger negative effects were experienced by those households at the top end of the distribution. The conflict was found to reduce inequality in the short-run, with the effects still persisting 10 years after the war.

The third essay addresses the impact of the 2014 Ebola outbreak in Sierra Leone on household poverty (measured both objectively and subjectively), food insecurity, and household expenditure distribution and inequality. We explore two Ebola treatment measures (confirmed cases and quarantined chiefdoms) to investigate the effects of both the disease itself and the policy responses to it on household welfare. The empirical analysis reveals that the overall impact of the Ebola virus was to reduce household expenditure and increase poverty and food insecurity. The evidence suggests that the quarantine policy implemented rather than exposure to confirmed cases within chiefdoms exerted more significant adverse effects on household welfare.

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1 Chapter One - Introduction

This thesis consists of three self-contained essays dedicated to an empirical analysis of the nexus between conflict, disease outbreak and household welfare in Sierra Leone. Specifically, the research initially investigates the relationship between the ten-year conflict endured by the country at the turn of the century and household expenditure, poverty, and inequality. It then explores the link between disease and household welfare by analysing household exposure to the West Africa Ebola outbreak and the impact of the quarantine policies imposed by the government on the same set of household outcome measures.

Each essay in the thesis investigates the impact of these two adverse economic shocks (conflict and disease outbreak) on dimensions of household welfare outcomes in Sierra Leone. The essays' themes are closely connected and have been the subject of research interest in past literature. However, the research questions investigated in this thesis address a significant gap in the literature, particularly at the micro-level of analysis. In the first essay, we explore the impact of the ten-year civil war on household welfare, as measured by household expenditure and poverty. A significant part of the existing literature has focused on evaluating the macro-level impact of conflict on socio-economic indicators, and this has mostly been undertaken using cross-country analysis. The more recent conflict literature has evolved around a more granular, micro-level investigation of genocide conflict, tribal or ethnic conflict, civil wars, and global wars. A significant strand of the existing micro-level empirical analysis has focused on the impact of conflict on human capital accumulation and labour market outcomes, with less research investigating the direct impact on household welfare itself. This first essay attempts to fill this gap and add to the literature on the effects of conflict on average household welfare.

Essay two elaborates and extends the research undertaken at the mean-level to investigate the impact of conflict on household inequality at selected unconditional expenditure quantiles in addition to a Gini-based measure of inequality. The existing literature in this area has generally been more descriptive in nature and again situated largely within a macroeconomic framework. Thus, this essay contributes to the existing literature on the important topic of conflict impact on household inequality at the micro-level and is one of the first to do so in a systematic fashion, detailing the mechanism through which conflict impacts the distribution of household expenditure. The third and final essay studies the impact of disease on household welfare in Sierra Leone. Thus, the household-level impacts of the West Africa Ebola epidemic are investigated for Sierra Leone. This empirical analysis contributes to the emerging literature relating to the impact of epidemics and pandemics on socio-economic indicators at the micro-level. It also highlights the mechanisms through which epidemics or pandemics adversely affect socio-economic outcomes.

The common contribution of the three essays is centred on the evaluation of the effects of economic shocks on household welfare indicators for a developing economy. The development process is at the heart of any developing country's economic agenda. The main objectives of development include increasing the standard of living and reducing poverty and thus inequality. These objectives have driven the poverty reduction strategies enacted by national governments in Africa in concert with international organisations like the World Bank and the International Monetary Fund in recent decades. The global focus on and effort against poverty, inequality, and low levels of household welfare, in general, were articulated in the Millennium Development Goals. The development goals have been adopted and set by many countries, especially those in Africa. The purpose of a country's economic policy is to provide an atmosphere that can enhance the prosperity of its citizens. Hence, economic shocks caused by

conflicts and diseases can have repercussions for growth and subject developing nations to a greater degree of poverty vulnerability. The mechanisms through which conflict and disease affect socio-economic indicators can be different, but the established findings corroborate their sharp negative effects. Hence, understanding the magnitude of the impact and its persistence (either short or long term) is important at the micro-level. It will help inform the nature and design of interventions at the individual household level that help strengthen household resilience.

Sierra Leone is an appropriate country for the analysis of the effects of conflict and disease on household welfare and inequality given its recent history. As a developing economy, it experienced ten years of civil war between 1991 and 2002. The civil war led to deaths, severe human rights violations, brutality, damage to physical infrastructure, and a substantial and persistent disruption of the economic system. The fact that the civil war was long-lasting and concluded over 15 years ago, however, provides the basis for an evaluation of the short-term and longer-term impacts of the conflict. The existing literature on the Sierra Leone civil war has largely explained its legacy in terms of its effects on institutions, local collective actions, and household socio-economic, firm-level, and asset ownership outcomes (see Miguel and Bellow, 2006, 2009; Collier and Duponchel, 2013; and Sam, 2015, respectively). A focus on household expenditure, poverty, and inequality has been neglected to date in the literature but is required in order to understand the micro-level impact of the conflict on households and evaluate the post-conflict recovery policies instituted by the government. Although Sierra Leone remained a fragile state post-conflict, its economy was on a trajectory of recovery and it was set to achieve middle-income country status by 2035 when hit by the shock of the 2014 Ebola epidemic. Regarding the disease outbreak, descriptive work has demonstrated a negative association with household welfare, food security, and poverty. This thesis examines the

evidence in more detailed and systematic fashion but finds broadly similar conclusions to those of the more descriptive literature.

Overall, the empirical work undertaken in this thesis confirms both a negative impact of conflict and health shocks on household welfare and substantial levelling effects on inequality. The conflict impact is persistent, while the disease impact is sharper and more short-term in nature. A key approach post-conflict was the introduction of financial and other support for the victims. The type of mitigating safety nets introduced by the government for conflict victims are not necessarily relevant for Ebola victims. This is because the conflict survival victims have physical scars that impede their economic capacity and productivity (for example, amputation or mental trauma), while the Ebola disease survivors exhibit more minor disabilities that are not significant enough to hinder their productivity in work-related activities.

All three essays build on micro-level theoretical arguments regarding the effect of conflict and disease on household expenditure, poverty (both total and food), and inequality. In addition, the empirical analysis uses reasonably high-quality household-level surveys conducted and compiled by the national statistics office of Sierra Leone in collaboration with the World Bank. The survey data are nationally representative and contain useful information for informing the empirical analysis. The first two essays also exploit conflict information data compiled from a thorough documentation of the Sierra Leone conflict contained in the No Peace Without Justice (NPWJ) report. This report presents detailed information on the civil war activities that occurred over the ten-year period. The final essay of the three exploits additional data on confirmed and suspected Ebola cases compiled by clinical experts who worked closely with public health in Sierra Leone. These additional data are at chiefdom level and are integrated

with the household survey data, providing a basis for the empirical identification strategies used in the empirical analysis of conflict and disease outbreak.

The thesis is structured as follows. The first chapter examines the Sierra Leone civil war's impact on two household welfare measures (i.e., household expenditure and poverty incidence). We evaluate the geographical variation of conflict intensity and the impact of directly incurred individual conflict events on the key outcome variables of interest. The chapter uses three rounds of household survey data from Sierra Leone (one before the conflict in 1989, and two after in 2003 and 2011, respectively) to identify the impact of the conflict on the welfare outcomes over both short-run and long-run periods. The empirical approach uses a propensity score matching (PSM) technique in conjunction with a difference-in-difference framework. The second chapter builds on the empirical work undertaken in the first essay and goes beyond the average effect to account for the conflict's distributional impact on household welfare. It examines the short-term and long-term impact of the Sierra Leone civil war on household inequality. First, we employ a recentred influence function (RIF) for the unconditional quantile regression models and the Gini coefficient. Second, to investigate the distributional welfare impact of the conflict on household expenditure, we estimate quantile treatment effects (QTEs) based on the work of Firpo (2007). In the third chapter, using chiefdom-level exposure to confirmed Ebola cases and the quarantine policy measures implemented by the government, we examine the impact of the Ebola epidemic two years after its outbreak on household expenditure, poverty, and inequality.

The key findings from the first essay reveal a negative reduction in household expenditure by a statistically significant 28.3% and an increase in household poverty of approximately 16 percentage points on average for households in chiefdoms subjected to protracted rule by rebel

groups. The negative consequences persisted a full 10 years after the end of the war. The findings in the second essay confirm the negative impact of the conflict across the household expenditure distribution with the top 10 percent of households incurring the greatest loss in welfare. On average, inequality as measured by the Gini coefficient decreased by 7.5 percentage points immediately after the civil war. The impact of the conflict on the inequality measure persisted 10 years after the war, with a slight reduction in magnitude for chiefdoms with protracted rebel group rule but not for the direct individual household effects.

The final essay confirms a negative impact of the Ebola outbreak on household expenditure and increased poverty status for households in chiefdoms subjected to the government's national quarantine policy. The level of inequality also decreased by 2.3 Gini percentage points, on average. Objective food poverty increased by 11.6 percentage points for the Ebola-quarantined chiefdoms. The impact is confirmed by the subjective food security estimates, which exhibit a similar negative impact.

The structure of the thesis is relatively straightforward, with each essay contained within the next three chapters. A concluding chapter brings some common themes together and outlines the agenda for future research.

2 Chapter Two - The Impact of the Civil War on Household Welfare in Sierra Leone (Essay 1)

2.1 Introduction

It is generally accepted that conflict impairs the economic development and social progress of affected countries and regions. It is associated with death and injury, the depletion of productive capital (both human and physical), the disruption of markets and social cohesion, and the weakening and erosion of civic and other institutional structures. It has been characterised by some as 'development in reverse' (for example, see Collier, Elliot, Hegre, Hoeffler, Reynal-Querol, and Sambanis, 2003). There is persuasive empirical evidence that it reduces economic growth at the macro-level (e.g., see Collier and Hoeffler, 1998, 2000) and negatively impacts household welfare at the micro-level (see Justino, 2011).

The theoretical framework used to model the economic impact of conflict at the macro-level has generally exploited Solow-type growth models, with the empirical literature emphasising a slow recovery after the end of conflict (see Barro and Sala-i-Martin, 2004; Rodrik, 1999; Collier, 1999; Azariadis and Drazen, 1990). Micro-level analysis has generally explored the impact of conflict on human capital outcomes relating to education and health, institutions, social cohesion, labour market participation, and household consumption (see respectively Shemyakina, 2011; Bundervoet, Verwimp, and Akresh, 2009; Bellows and Miguel, 2006, 2009; Serneels and Verpoorten, 2015). In contrast, understanding the patterns of household expenditure and poverty profiles that emerge as a consequence of conflict has attracted less research interest at the micro-level. The limited nature of the data available on household- and individual-level conflict experience, in conjunction with an absence of compatible data prior to and after a conflict, has posed particular challenges for researchers in this field. The objective of this study is to provide new evidence for the case of Sierra Leone, with its unique but

devasting experience of the longest civil war in sub-Saharan Africa. This will provide additional and complementary evidence for the small amount of existing researched focused on the micro-level impact of conflict in other countries.

This paper uses a number of household-level surveys from Sierra Leone to directly examine the legacy of conflict relating to the country's civil war, with a specific emphasis on its household welfare and poverty consequences. The conflict spanned the period from 1991 to 2002 and led to a conservatively estimated 50,000 fatalities, with many more injured. It also temporarily displaced about two million of the population, damaged the country's physical and social infrastructures, and disrupted economic activity. A peace agreement between the warring factions (i.e., the government and the rebels) was eventually signed in 2002. The subsequent peace helped stimulate a modest economic recovery but one that was sluggish in character. The primary objective of this study is to examine the short-term and long-term impacts of the conflict on household welfare using both a household expenditure metric and a household poverty incidence measure.

The potential endogeneity of conflict poses a challenge for identifying the causal impact of the war on household welfare. Therefore, the empirical approach exploits a propensity score matching (PSM) technique to estimate a difference-in-difference average treatment on the treated effect using cross-sectional data across three separate time periods. One of the household surveys available pre-dates the conflict and provides the baseline for analysis, while the other two were conducted, respectively, immediately after the end of the conflict and about ten years later. The empirical approach exploits the fact that the intensity of the conflict and the incidence of protracted territorial occupation by rebel forces was concentrated in certain geographical areas of the country. In particular, some areas of the country remained largely

unaffected by the conflict and not subject to rebel force occupation. These largely unaffected areas provide the control group for a core part of the empirical analysis undertaken in this paper.

Our empirical findings reveal that households located in areas that experienced intensive conflict and protracted rebel force occupation exhibited lower household expenditure levels and were more likely to be in poverty in the immediate aftermath of the war. In particular, the short-run impact of the civil war is estimated to have reduced total household per capita expenditure in Sierra Leone by approximately 28%. The proportion of households below the poverty line increased by about 16 percentage points. These welfare estimates comport with those reported in the existing and fairly sparse literature for other African conflicts. Further, the estimated effects did not dissipate markedly ten years after the war in those areas subject to intense conflict and protracted rebel control, confirming a very slow post-war recovery process.

The remainder of the essay is organised as follows. The next two sections outline respectively the contextual background and some relevant literature within which the empirical analysis is situated. Two subsequent sections focus on data issues including the construction of the conflict measures. These are followed by two further sections that focus in turn on the econometric methodology used and the empirical results obtained. The penultimate section provides some robustness checks, and the final section provides some concluding remarks.

2.2 Contextual Background

Sierra Leone is located in West Africa and covers a geographical area of 71,740 square kilometres. It gained independence from Britain in 1961. In its first 30 years of self-rule the

country endured poor governance, with corruption a hallmark of both the civilian and military administrations that had assumed power. In the years preceding the start of the war in 1991, the economy experienced very poor growth rates and the resultant low per capita income levels confirmed the country's status as one of Africa's (and indeed the world's) poorest. This led to widening economic discontent among the population, encouraging some degree of sympathy with the Revolutionary United Front (RUF) rebel group. It was this faction, with the support of Charles Taylor's National Patriotic Front of Liberia, that originally launched an invasion of the country from neighbouring Liberia in March 1991 in an attempt to overthrow the then military-led Sierra Leone regime of Joseph Momoh. The conflict started in the Eastern region of the country, with rebel forces eventually reaching as far as the outskirts of the capital of Freetown by early 1999.[1]

The government of Sierra Leone was allied with a coalition of international forces in opposing the rebels and preventing their encroachment into all parts of the country. The western area, and some chiefdoms in the north, were protected by an array of international military forces drawn from the United Nations, the British Army, the Economic Community of West African States Monitoring Group (ECOMOG), the privately-hired Executive Outcomes, and the local Civil Defence Forces (CDF). This significant military presence and the poor inter-connections provided by road networks to neighbouring chiefdoms restricted the activities of the rebel forces to certain areas of the country.

[1] The natural resources of Sierra Leone (e.g., diamonds) are often implicated as providing one of the key motives for the war in Sierra Leone. However, the work of Voors, Van der Windt, Papaioannou, and Bulte (2017) reports no evidence that natural resources triggered the onset or affected the duration of the country's civil war, although Keen (2005) suggests otherwise. However, see Bazzi et al. (2019) for an interesting study on the difficulties in predicting conflict outbreak in other countries beset by conflict.

The conflict was one of the longest within the Economic Community of West African States (ECOWAS). It was also viewed as one of the most brutal in terms of acts perpetrated largely by the rebel groups (e.g., killings, limb amputations, rape, and the destruction of private property and public infrastructure). Military action was heavily concentrated in certain geographical areas of the country, with households in the Eastern regions in particular exposed to intense violence and a protracted period of occupation by RUF forces. Although the conflict extended its geographical reach during the course of the war, it had limited impact in the western and northern areas of the country. The delineation of chiefdoms into those under the authority of the government and those under rebel occupation for extended periods of time is exploited in implementing the empirical strategy for this study.[2]

A peace agreement was signed in Lomé in 2002, marking an official end to the conflict. The recovery process was underpinned by post-war support from international organisations including the World Bank, the United Nations Development Program (UNDP), USAID, the UK's Department for International Development (DfID), and a variety of non-governmental organisations (NGOs). A Truth and Reconciliation Commission (TRC) was established prior to the end of the war following the passage of an act of the Sierra Leone Parliament in 2000. The subsequent TRC findings were released in October 2004 (see Conibere, Asher, Cibelli, Dudukovich, Kaplan, and Ball, 2004). The TRC report, based on an evaluation of the insurgency and conflict-related activities that had occurred during the war, outlined a set of recommendations for post-conflict recovery. One of the recommendations was the provision

[2] The chiefdom represents the finest level of regional disaggregation in Sierra Leone. There were 152 chiefdoms in Sierra Leone during the time governing the empirical analysis undertaken in this particular study. The chiefdoms were originally a legacy of British colonial rule, with paramount chiefs appointed by the colonial authorities to rule the interior of the country outside Freetown. As noted by Acemoglu, Reed, and Robinson (2004), the powers of the chiefs endured beyond the colonial era and have been implicated in weakening the effects of state institutions post-independence.

of a reparation programme for war victims who were wounded or suffered war-related amputations, had been subject to sexual violence, or were war widows.

A Sierra Leonean government institute, the National Commission for Social Action (NaCSA), was tasked with proposing and implementing a strategy to provide social service packages to war victims in accordance with the terms of the peace agreement and the recommendations of the TRC. These interventions were first introduced in 2009 and were intended, *inter alia,* to enhance the livelihood skills of war victims and their families. The implementation of the reparation programme in conjunction with a war victims' trust fund was launched by the then president of the Republic of Sierra Leone with the assistance of the United Nations Peace Building Fund (UNPBF). The primary purpose of the fund was to provide financial support for war victims to mitigate the extreme effects of poverty, disability, trauma, and unemployment risk (see NaCSA Newsletter, 2016).

2.3 Literature Review

The proliferation of civil wars in the aftermath of World War Two has attracted the research interest of economists. The literature has used economic theories and empirical methods to test propositions about the determinants, duration, and costs of such conflicts, in an attempt to explain them in order to prevent them occurring in the future. The popular theoretical base has been whether greed or grievance is the motivating factor, and the conclusions have centred around a reverse two-way relationship between economic growth and conflict. Poor economic conditions can increase a population's frustration and can invoke conflict as a fight against the status quo. Economic frustration can be caused by greed or grievance. However, there is strong empirical support for the greed concept (Hoeffler and Collier, 2004). Likewise, conflict activities have been found to have a negative impact on economic conditions. In essay two, we provide a more in-depth discussion on the two-way relationship between conflict and economic growth and extend it to inequality.

One of the most influential pieces of macroeconomic research on the economic effects of conflict was undertaken by Collier and Hoeffler (1998). The authors conducted a cross-country analysis of 92 countries from 1960 to 1989 and found that economic growth decreased by 15% after seven years of conflict. The broad magnitude of their findings was corroborated in later work by Hoeffler and Reynal-Querol (2003), who reported a drop of about 2% of GDP per annum after five years of conflict. At the macroeconomic level, the literature suggests that civil war induces a sharp reduction in per capita income, which also has the potential to trigger a resurgence in conflict (see Collier and Hoeffler, 1998; Fearon and Laitin, 2002). In the analysis of African countries between 1981-1999, a negative causal relationship has been predicted between economic growth and the incidence of civil conflict, using rainfall as an instrumental variable for economic growth. Miguel, Satyanath, and Sergenti (2004) confirmed that a

reduction in growth rate by 5 percentage points increases the likelihood of civil conflict by 1.5 percentage points in the following year.

It is fairly well established that conflict in its many forms (e.g., civil war, ethnic violence, and genocide) leaves in its wake a horrific set of legacies. Depending on its scale and reach, it has the potential to propel households into extreme forms of poverty (see Verwimp, 2005; Bundervoet and Verwimp, 2007; Shemyakina, 2011; Justino, 2009). Justino and Verwimp (2008) evaluated the effect of the Rwanda civil war and genocide on household welfare and poverty dynamics using household consumption data. The authors found that households with destroyed or lost land incurred a 20-percentage point higher risk of entering into poverty. Ibáñez and Moya (2010) used household-level data for war-displaced Colombians to estimate welfare loss and analyse the coping strategies adopted. The authors computed a 19% contraction in household consumption consequent on forced migration.

Arcand and Wouabe (2009) studied the 27-year civil war in Angola and attempted to address conflict endogeneity by instrumenting a conflict intensity variable using the distance of a local community from the rebel headquarters. They found no statistically significant effect on either household expenditure or school enrolment in the short-run, though the quality of the identification used in this study was questionable. In contrast, the work of Bozzoli and Bruck (2009) for the northern Mozambique conflict reported a reduction in per capita household welfare of between 16% and 31% for households engaged in cotton production.

As already noted, the empirical evidence on the effect of the Sierra Leone conflict is limited and largely focuses on its effects on political engagement, local institutions, individual behavioural responses, and enterprise-level outcomes. For instance, Bellows and Miguel

(2009) used individual-level data from three household surveys collected after the war to construct victimisation indices for 2005 and 2007. The authors found that individuals in conflict-affected communities tended to be more politically engaged, made larger contributions to public goods, and were more likely to be members of social and political groups.

Cecchi, Leuveld, and Voors (2016) explored the effect of conflict exposure on the competitive behaviour of young people in both a local street football tournament in Sierra Leone and in a series of laboratory experiments. The authors found that exposure to conflict when young fosters greater in-group co-operation but exacerbates out-group antagonism. The authors concluded that this also poses a challenge to policy-makers, who need to appreciate the potential impact of conflict in altering behaviour, preferences, and beliefs. Collier and Duponchel (2013), using firm-level data from the Sierra Leone Employers' Survey (SLES), investigated the effect of the conflict on selected enterprise-level outcomes. The authors provided evidence that the conflict had a negative impact on the existence of firms, their size, and their employment levels.

Overall, the foregoing suggests a gap in the existing literature investigating the direct impact of the Sierra Leone conflict on household welfare and poverty. The civil war in Sierra Leone is a unique case for study, as the rebel activities somewhat differed from those suggested by the conflict insurgency theory of greed or grievance. The rebels' brutality, inflicted on the very people they claimed to be protecting, is an interesting addition to the conflict literature. The 10-year civil war was lived through and become an embedded part of the country rather just having a one-off impact. Hence, the dynamic episodes of the civil war in Sierra Leone are an interesting feature for the welfare and poverty status of the country. A key motivation of this

paper is to fill this gap and augment the fairly modest empirical literature on the micro-level relationship between conflict and household welfare for Sierra Leone and Africa in general.

2.4 Data Description

The 1989 Sierra Leone Household Survey (SLHS) and the 2003 and 2011 Sierra Leone Integrated Household Surveys (SLIHS) implemented by Statistics Sierra Leone in association with the World Bank provide the main data sources for this study. These data reflect household welfare and socio-economic status prior to the war (1989) and at two points in time (2003 and 2011) after the peace settlement was agreed in 2002.

A key difference between the sampling approach used in the earliest survey in 1989 and that of the two later surveys was that sampling was restricted to a randomly selected set of 64 chiefdoms from a total of 152 in Sierra Leone for the initial survey, whereas the sampling of households was drawn from all 152 chiefdoms in the follow-up surveys undertaken in 2003 and 2011. We investigate, as part of a robustness check, whether the econometric estimates reported are sensitive to the more restrictive chiefdom sampling used at the baseline in 1989.

We construct two welfare metrics for each of the three years. First, we construct a logged measure of per capita household expenditure. Second, we use the household expenditure data to determine whether a household is above or below the relevant national poverty line for Sierra Leone. The resultant outcome variable is expressed as a binary measure adopting a value of 1 if the household is found to be below the national poverty line and 0 otherwise.

The 1989 survey data collected before the onset of the civil war provide a baseline or benchmark for calibrating the welfare status of households against which the conflict effects are subsequently compared. The later 2003 and 2011 SLIHS datasets provide information

respectively on the immediate and longer-term post-war socio-economic status of households. In particular, the first post-war survey permits the empirical estimation of the short-term effects of the civil war on the two household welfare outcomes. The more recent of the two post-war surveys provides insights on how household welfare was affected by the conflict nearly ten years after the war's end. Hence, this survey may also potentially reflect the impact of the war-related reconstruction and rehabilitation programmes implemented by the government of Sierra Leone from 2009 onwards.

The empirical strategy used entails allocating households to chiefdoms within Sierra Leone that were either characterised by high conflict intensity and protracted rebel occupation (i.e., the treatment group) or by low/no conflict intensity and limited/no protracted rebel occupation (i.e., the control group). The conflict brought substantial destruction to areas that experienced prolonged rebel occupation. In contrast to the eastern chiefdoms, the western and some northern ones witnessed limited or even no conflict due to the protection provided by government and other forces, and thus remained largely free from rebel occupation. The rebel penetration of the western and surrounding areas occurred near the end of the war, was transient in nature, and exerted minimal impact on the economic activity of the populations located within these areas.

In order to classify households by their conflict exposure, we create a conflict dummy variable that captures conflict incidence by exposure to violence and the degree of rebel occupation in each administrative chiefdom. The conflict intensity data used to construct this dummy variable are obtained from the No Peace Without Justice report (see Smith, Gambette, and Longley, 2004). The binary measure for a household's exposure to the conflict is defined as 1 for those households in chiefdoms that experienced a protracted period of rebel group activity and

occupation (as defined by the presence of a rebel military headquarters in the chiefdom for more than eight years) and a high incidence of conflict-related death and other war-related activities, and is coded 0 otherwise. The eight-year threshold for protracted rebel rule is used because the peace talks, which halted the rebels' invasion and activity, began after eight years of war. The start of the peace talks reduced rebel activity, and although some level of danger remained in some occupied regions, it was not as substantial as in the first eight years. The construction of the dummy variable is restricted to using chiefdom-level information as this represents the finest compatible level of regional disaggregation available across the three datasets. Table A2.1 of Appendix 1 lists the chiefdoms allocated to the treatment and control groups by survey year.

It is again emphasised that the treatment not only reflects the experience of conflict-related violence but also the influence of protracted rebel occupation. The occupation endured for most of the war for those within this treatment group and was characterised by an absence of the 'rule-of-law', the perpetration of sometimes gratuitous acts of brutality by (mostly) rebel forces, a failure to maintain physical infrastructure, and an absence of investment in health and educational facilities. Therefore, the treatment exposure is interpreted in broader terms than that captured or described by conflict intensity alone. Its definition also captures more explicitly the mechanisms through which the civil war potentially impacted economic activity and thus household welfare in Sierra Leone.

In order to examine the robustness of our core empirical results using the treatment and control groups defined above, an alternative treatment measure is also constructed to capture the impact of the conflict on household welfare. This uses information on households that have directly suffered war-related events (e.g., family or relatives killed, limbs amputated, property

destroyed or lost, household members raped, or household members displaced). The data obtained for this measure are based on respondents' answers to questions about the conflict in the two post-war integrated household surveys from 2003 and 2011. This alternative conflict measure is again a binary variable that equals 1 if an individual in a household (or the household itself) is reported to have suffered from any of the stated events listed above and is 0 otherwise. In essence, this construct captures whether or not a member (or members) of the household report themselves as war victims.

2.5 Selected Summary Statistics

The kernel density plots for the log of per capita household expenditure by conflict exposure status are depicted in Figures 2.1 to 2.3 for the years 1989, 2003, and 2011, respectively. The density plots for the first year (see Figure 2.1) roughly overlap with each other with little marked evidence of a significant difference in the central location of the distributions between the conflict and non-conflict zones. In contrast, the density plot for the non-conflict areas in 2003 (see Figure 2.2) exhibits a locational shift to the right compared to the corresponding plot for the conflict zones. A similar pattern is evident also in the density plots for the most recent year of 2011 (see Figure 2.3).

Table 2.1 provides summary statistics for the two outcome variables (i.e., the log of per capita household expenditure and the poverty rate) by conflict exposure for the three years (i.e., prior to the civil war (1989), immediately after the civil war (2003), and then almost ten years after the civil war had ended (2011)). No statistically significant difference in the mean log per capita expenditure between the treatment and control zones is detected prior to the start of the conflict. However, there exists evidence of a statistical difference in the poverty rates between what became the conflict and non-conflict zones, with the former actually exhibiting lower poverty

rates, on average, prior to the civil war. In contrast, in the immediate aftermath of the conflict the households in the conflict zone exhibit statistically significant lower average expenditure levels and considerably higher poverty rates. These gaps persist for both household welfare measures to 2011 and exhibit only a very modest tendency to decline. The negative association is also visible for the conflict event measure in the short-run (see Table A2.2 in Appendix 1).

Table 2.1 Summary Statistics of Expenditure and Poverty Rate and Conflict Exposure

	1989			2003			2011		
	Conflict	Non-conflict		Conflict	Non-conflict		Conflict	Non-conflict	
	Mean	Mean	t-test	Mean	Mean	t-test	Mean	Mean	t-test
Log per capita expenditure	5.85	5.80	0.81	13.32	13.58	-5.18	13.82	14.06	-6.04
	(1.78)	(1.62)		(1.51)	(1.53)		(1.52)	(1.69)	
Poverty rate	0.71	0.78	-4.38	0.80	0.68	8.44	0.57	0.41	13.87
	(0.45)	(0.41)		(0.39)	(0.46)		(0.50)	(0.49)	
Sample Size	1167	2272		1666	2036		2591	4172	

Notes to Table 2.1: standard deviations are reported in parentheses.
Conflict exposure refers to whether a household is located in the conflict-affected chiefdoms as defined in the text.

Figure 2.1 Distribution of Household Expenditure by Conflict Exposure (1989)

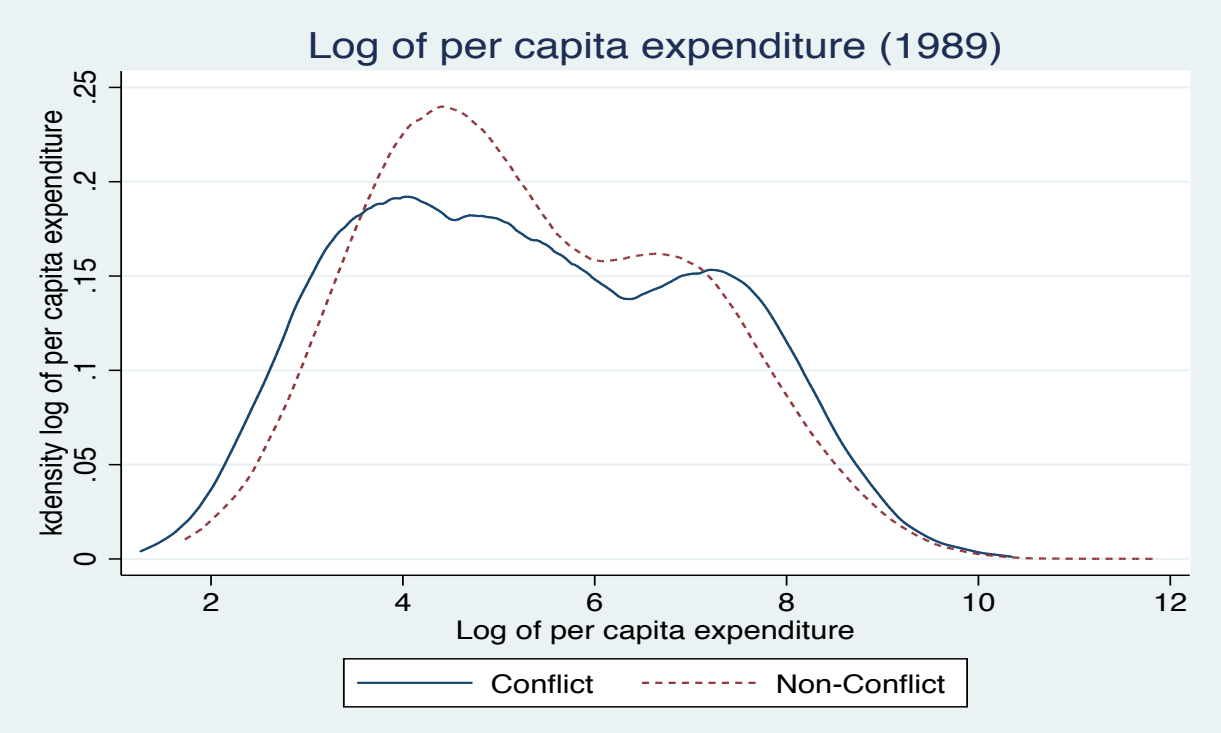


Figure 2.2 Distribution of Household Expenditure by Conflict Exposure (2003)

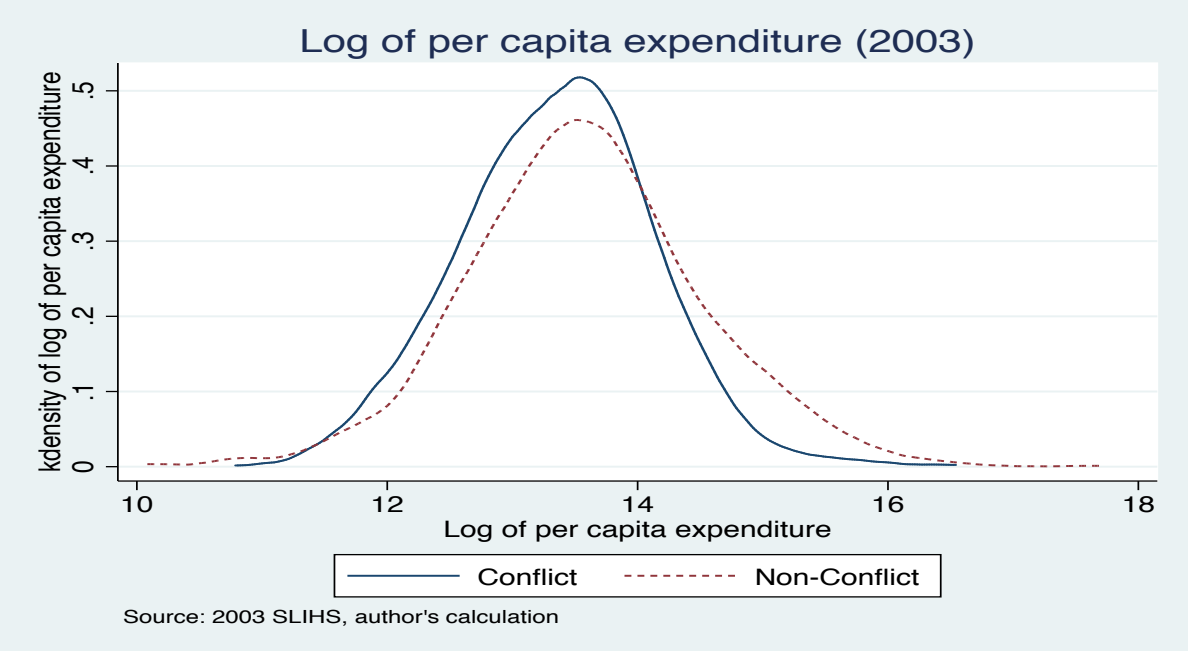
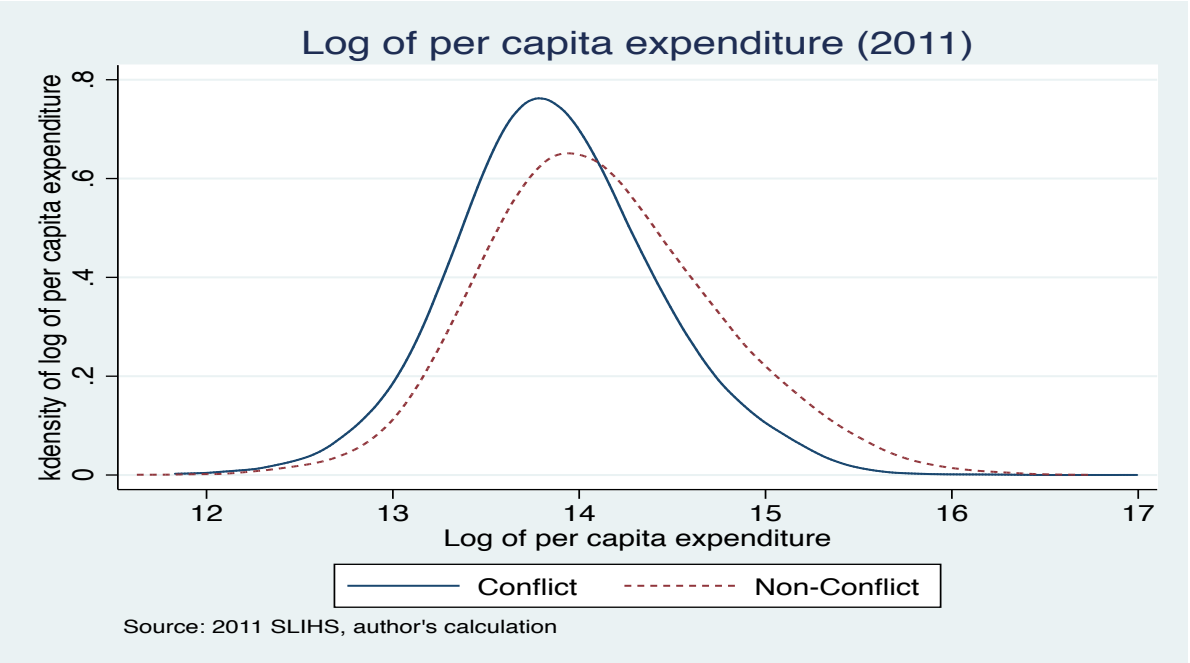


Figure 2.3 Distribution of Household Expenditure by Conflict Exposure (2011)



The household survey data also contain information on individual and household-level characteristics. These include, *inter alia,* the age of the household head, the head's educational level, the head's marital status and gender, the household dependency ratio, and the household's settlement type. These variables comprise the input variables for the empirical

methodology used in this study (see section below). Table 2.2 provides selected summary statistics for these variables by treatment and control groups.

Table 2.2 Summary Statistics of Household Characteristics by Conflict Exposure

	1989		2003		2011	
	Conflict	Non-conflict	Conflict	Non-conflict	Conflict	Non-conflict
***Head's characteristics**:*						
Age	44.43	43.75	46.80	46.19	45.70	45.48
	(11.44)	(11.91)	13.99	14.29	14.69	13.84
Age squared	2104.39	2056.01	2386.05	2337.35	2304.36	2259.98
	(1119.90)	(1193.83)	1461.48	1483.03	1515.09	1409.95
Gender: Male	0.87	0.85	0.82	0.80	0.73	0.75
Female	0.13	0.15	0.18	0.20	0.27	0.25
Education: Primary	0.68	0.56	0.09	0.08	0.07	0.09
High	0.32	0.44	0.02	0.04	0.12	0.10
Secondary	-	-	0.12	0.20	0.05	0.21
No education	-	-	0.75	0.64	0.76	0.59
Marital Status: Married	0.92	0.92	0.84	0.79	0.81	0.77
Cohabiting	0.04	0.06	0.01	0.01	0.01	0.01
Other status	0.05	0.09	0.15	0.16	0.15	0.15
Single	0.02	0.02	0.01	0.03	0.03	0.06
Tribes: Mende	-	-	0.38	0.37	-	-
Temne	-	-	0.24	0.23	-	-
Other tribes	-	-	0.38	0.40	-	-
Religion: Muslim	-	-	-	-	0.78	0.74
Christian	-	-	-	-	0.21	0.25
Other religions	-	-	-	-	0.01	0.01
***Other characteristics**:*						
Urban	0.33	0.35	0.30	0.40	0.17	0.48
Dependency ratio	0.99	0.91	0.95	0.94	1.08	1.15
	0.91	0.93	0.90	0.87	1.03	1.16
Household size	6.16	5.29	6.28	6.11	5.65	5.62
	4.05	3.34	2.61	2.85	2.47	2.67
Household size squared	54.37	39.14	46.28	45.43	37.98	38.76
	69.71	50.22	40.48	45.55	35.66	42.79
Sample size	1167	2272	1666	2036	2591	4172

Notes to Table 2.2: Standard deviations for continuous variables reported in parentheses; Conflict exposure refers to whether a household is located within the conflict-affected chiefdoms as defined in the text.

2.6 Econometric Methodology

Table 2.1 above provides an indication of a negative correlation between household welfare and the Sierra Leone conflict. However, this does not provide evidence of a causal effect. Therefore, a propensity score matching (PSM) technique is used in an attempt to causally identify the key effects of interest. The procedure is applied separately to the cross-section of households prior to the conflict and then to the two post-conflict datasets. This then allows the use of a difference-in-difference procedure to eliminate the influence of any time-invariant confounding factors that may impact the outcome measure of interest here.

The first step of the empirical approach is to estimate a treatment assignment equation using a logistic regression model. In the case of the conflict exposure measure, the probability that a household is in a conflict-intensive and protractedly rebel-occupied zone (i.e., the treatment group) is empirically predicted. The specified logistic regression model includes as explanatory variables a set of household head and household-level characteristics. The specification used is not informed by economic theory and may comprise polynomial and interactive terms for the covariates. The specification is largely driven by the need to achieve good predictions and effective covariate balancing in the matching. The model estimates are used to construct the propensity scores on which the households from the two groups are subsequently matched. The variables used in the logistic regression are assumed to be correlated with the outcome variables but uninfluenced by the conflict to avoid any threat to the internal validity of the approach. The identifying assumption is that conditional on the input variables, the assignment to the treatment group (i.e., high conflict intensity areas with protracted rebel occupation) and the control group (i.e., low/no conflict intensity areas with limited/no protracted rebel occupation)

can be regarded as random and independent of the treatment. This is known as the unconfoundedness assumption, or the conditional independence assumption (CIA).[3]

The treatment and control groups used are restricted to a common support which eliminates those cases for which the propensity scores for the treatment and control observations do not overlap. Epanechnikov kernel density with a bandwidth of 0.06 is used for matching purposes. This bandwidth is found to be the most effective in all cases and it should be noted that adjusting the bandwidth by a small margin above or below 0.06 does not materially alter the estimated treatment effects reported in this paper.

After implementing the matching exercise, the pre-determined (or input) variables for the treatment and control groups are required to have a similar distributional pattern. If the quality of the match is satisfactory, the households assigned to the treatment and control groups should be observationally identical in terms of the marginal distributions of the input variables. If this balancing property is satisfied, this implies that no measured confounder bias remains. The property is assessed using a number of different diagnostics. These include the standardised bias approach suggested by Rosenbaum and Rubin (1985), which measures the distance in the marginal (or unconditional) distributions of the input variables between the control and treatment groups both prior to and after matching. In addition, t-statistics and variance ratios (i.e., F-tests) for each variable included in the treatment assignment equation are also used to determine if there are statistical differences between the means and variances (of the continuous input variables) after matching. In investigating the balancing property, the logistic treatment assignment model is also re-estimated using the set of matched data. The expectation is that

[3] See Heckman, Ichimura, and Todd (1997), Smith and Todd (2005), and Caliendo and Kopeinig (2008) for detailed reviews and assessments of the propensity score matching technique.

with good matching, the regression model's pseudo-R^2 should be close to zero and the corresponding Likelihood Ratio Test (LRT) for the overall statistical significance of the logistic regression model should yield a low value. We also use Rubin's B and R statistics (see Rubin, 2001), which provide a set of criteria for comparing the distribution of the propensity scores between the treatment and control groups. These latter two test statistics indicate whether the regression-based procedure adequately eliminates any measured confounder bias using an appropriate set of confidence intervals.

Once the balancing property is satisfied, the impact of the treatment (i.e., the conflict) is obtained as the average difference between the treated units and the weighted average of the comparator units in the control group, where the standardised weights are based on the magnitude of differences in the propensity scores between individual treated units and the comparator control units. The average treatment on the treated (ATT) effect is computed using the data from all three survey years. This is defined for the period prior to the conflict (1989) as ATT_0. The immediate post-war ATT effect using the 2003 survey is defined as ATT_1, while the long-term ATT effect from the 2011 survey is expressed as ATT_2. The difference between each of the two post-war ATTs and the baseline pre-war ATT_0 (i.e., the difference-in-difference) is taken to represent the causal impact of the conflict for the subset of households subjected to conflict in the short-run and long-run respectively.

In contrast to a cross-sectional PSM approach, which eliminates any biases attributable to measured confounders, the difference-in-difference approach is more effective in dealing with bias from unmeasured confounders, provided these are immutable across time. Therefore, the combination of both approaches in the current application eliminates potential estimation biases that have their provenance in either of these approaches. The computation of the

analytical standard errors is not straightforward in the PSM framework, given the predicted nature of the standardised weights used for the matching. Therefore, a bootstrapping method with 250 replications is used to estimate the standard errors of the various ATTs reported in this study.

It is acknowledged that the definition of the primary conflict treatment measure raises a number of concerns that may potentially challenge the identification strategy used here. First, there were circumstances when chiefdoms allocated to the control group by this definition were exposed to very short periods of intense violence during the civil war. The most notable episode occurred on January 6th, 1999, when rebel forces breached the western defensive perimeters protecting the capital of Freetown and engaged in an intense, three-day battle with government and allied forces. The rebels were eventually expelled from the municipality and order was restored by the end of that month. However, we re-emphasise that our definition of the treatment is broader than simply the incidence of conflict and relies more heavily on the protracted nature of rebel force occupation in particular chiefdoms. It was the extended nature of the occupation that provided the primary channel through which the economic activity of these chiefdoms was undermined and adversely affected.

Second, it could be argued that the geographical allocation of households to zones with no (or minimal) conflict intensity and no protracted rebel occupation (i.e., the control group) neglects the fact that some households may have escaped, migrated, or been displaced from conflict-zones to the non-conflict zones. This creates a potential spill-over effect, which might bias the estimated effect of conflict on household welfare. However, it should be stressed that during the civil war there were tight restrictions on individuals entering the non-conflict zones, as they were heavily protected by the government coalition of armed forces. In particular, the road

network during the war period was not well maintained and was regularly subject to military checkpoints. The population generally moved by foot in a bid to avoid contact with rebels. This constrained the distances actually travelled by the displaced and explains why most movement was restricted to within the conflict-affected zones. Thus, there was minimal opportunity for movement of individuals into the government-controlled zones. Overall, although there was significant displacement, movement was restricted to within the conflict-affected areas and rather than between the conflict and non-conflict zones. Therefore, we believe this type of spill-over effect is likely to exert a small effect on the key short-run estimates of interest. Nevertheless, this issue is explored in more detail when discussing the empirical results below.

Finally, the treatment assignment equation is also specified using an alternative treatment measure based on whether a member (or members) of a household or the household itself was affected by conflict-specific events. Essentially, this models the treatment on the basis of whether the household self-reports that it contains a war victim or not. This treatment assignment equation is only estimable for the two later surveys, so the computation of a difference-in-difference estimate relative to the baseline of 1989 is not feasible. Nevertheless, the use of an alternative, complementary, household-specific conflict measure based on war victimhood rather than the exposure measure permits an assessment of the robustness of the ATT estimates obtained using the chiefdom-level treatment exposure definition.

2.7 Empirical Results

Table 2.3 presents estimates for the treatment assignment models used to generate propensity scores for all three years and both treatment definitions. Given the need for a good balance in the distribution of the covariates across both groups, the specifications differ slightly between years. Further, as noted earlier, there is no underlying economic theory that motivates the specification and the estimates are not amenable to an economic interpretation. The key objective of the exercise is to obtain a regression model that yields sufficiently adequate predictive power to ensure good propensity scores for the matching exercise. Only a small number of household observations failed to satisfy the common support condition. The pre-war sample registered just one observation outside the common support. In the 2003 (2011) post-war sample four (13) observations in the control group were outside the common support. In all cases, these observations are excluded from the empirical analysis.

The matching exercise yielded good balancing quality for the input variables for all three years. The variance ratios for the continuous variables for the treatment and control groups lie within the specified 95% confidence intervals. The mean and median standardised bias estimates are well below the required threshold and none of the individual variables yields a standardised bias outside the ± 5% range. The Pseudo-R^2 values for the logistic regression models re-estimated using matched data are negligible and the LRT values for the overall significance of these regression models are statistically insignificant in all specifications. The estimated Rubin criteria for good balancing are both satisfied in all cases. The full array of statistics and diagnostics for the balancing property for all years is contained in Tables A2.3 to A2.6 (inclusive) of Appendix 1.

Table 2.4 reports the impact of conflict exposure and conflict-specific events on household per capita expenditure and poverty status separately. Column (1) reports, among other things, the ATT estimates of the conflict on log household expenditures for the three separate years. The initial interpretation focusses on the treatment estimate based on conflict exposure and rebel occupation in the immediate aftermath of the civil war. The point estimate for the average log difference in per capita household expenditures for the matched households between the conflict and non-conflict zones prior to the conflict is found to be positive and suggests a 16% advantage for the treatment group. However, this point estimate is not statistically significant at a conventional level (prob-value = 0.103). Thus, prior to the conflict, the evidence suggests no statistical difference in average household expenditure between the control group and what subsequently became the treatment group.

The immediate (or short-run) post-war average treatment effect (ATT_1) in column (1) reveals a significant decrease in average household expenditure for those households located in the conflict-affected chiefdoms compared to those that are not. The estimated effect suggests a 15.4% reduction (i.e., $[e^{-0.1674} - 1]\times100$) in average per capita household expenditure for those in the conflict zones. Therefore, the causal effect, which is based on the difference-in-difference between the two ATTs, suggests the civil war significantly reduced the average expenditure of those households in the high-conflict intensity and protractedly rebel-occupied chiefdoms by approximately 28.3% (i.e., $[e^{-0.3331} - 1]\times100$). This represents a substantial loss in household welfare of approximately 2.2% for each year of the conflict.

Table 2.3 Logistic Treatment Assignment Model for Conflict Exposure & Conflict Events

	1989	2003		2011	
	Conflict Exposure	Conflict Exposure	Conflict Events	Conflict Exposure	Conflict Events
Age of head	0.0079	0.0183	0.0275*	-0.0364***	0.0229*
	(0.0199)	(0.0138)	(0.0159)	(0.0105)	(0.0119)
Age of head squared	-0.0002	-0.0002	-0.0002	0.0003***	-0.0002
	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
Head male	0.2060	-0.1920	0.6200***	-0.0640	-0.2460**
	(0.1260)	(0.1540)	(0.1850)	(0.0825)	(0.1130)
Head married	-0.0147	-0.1640	-0.5680***	-0.0603	0.5640***
	(0.1630)	(0.1660)	(0.2080)	(0.0990)	(0.1250)
Dependency ratio	0.0241	0.0530	-0.0995*	-0.0230	0.0943**
	(0.0554)	(0.0499)	(0.0589)	(0.0309)	(0.0456)
Urban	-0.1180	-0.9780***	-1.0820***	-2.1270***	-1.3130***
	(0.1490)	(0.2460)	(0.2840)	(0.2010)	(0.2020)
Head with prim educ	0.5350***	-0.0175	0.8820***	-0.2280*	0.3490*
	(0.0804)	(0.1600)	(0.2240)	(0.1250)	(0.1830)
Head with higher educ	-	-0.4690**	-0.4780**	-0.0724	-0.1930*
		(0.2060)	(0.204)	(0.1230)	(0.1080)
Household size	-0.0322	0.2100***	-0.2750***	-0.00466	0.0749**
	(0.0376)	(0.0492)	(0.0601)	(0.0297)	(0.0326)
Head with prim educ × urban	-	0.4080*	-0.7670**	0.0986	0.1780
		(0.2430)	(0.303)0	(0.2190)	(0.2390)
Head male × urban	-	0.1310	-1.1420***	-0.3100**	-0.0545
		(0.2570)	(0.2980)	(0.1570)	(0.1590)
Dependency ratio × urban	0.0530	-0.0706	-0.3260***	-0.0557	-0.2180***
	(0.0873)	(0.0799)	(0.0948)	(0.0545)	(0.0565)
Household size squared	0.00615***	-0.0114***	0.0086**	-0.0019	-0.0046**
	(0.0022)	(0.0030)	(0.0035)	(0.0018)	(0.0019)
Household size × urban	0.0023	-0.0409	0.0953***	0.0886***	0.0867***
	(0.0229)	(0.0268)	(0.0297)	(0.0225)	(0.0237)
Head married × urban	-0.2000	0.9670***	1.5520***	0.3900**	-0.2300
	(0.3260)	(0.2620)	(0.3110)	(0.1710)	(0.1670)
Head Muslim	-	0.3300***	0.5200***	-0.0841	-0.1030
		(0.0836)	(0.0940)	(0.0771)	(0.1050)
Head × Temne tribe	-	-0.0129	-1.7110***	-	-
		(0.0817)	(0.0911)		
Head × Muslim × urban	-	-	-	0.1510	0.3630***
				(0.1410)	(0.1410)
Constant	-1.2940***	-1.2990***	1.4490***	1.2150***	0.3500
	(0.4860)	(0.3930)	(0.4650)	(0.2740)	(0.3120)
LRT	105.55	137.95	590.44	781.26	552.67
LRT prob-value	0.0000	0.0000	0.0000	0.0000	0.0000
McFadden R^2	0.0240	0.0271	0.1290	0.0868	0.0740
Observations	3439	3702	3697	6763	6685

Notes to Table 2.3: Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

The foregoing estimate comports with the findings of Sevastianova and Polachek (2010) who exploited panel data comprising 90 war-affected (including many African) countries, albeit using an alternative and broader measure of aggregate welfare (i.e., per capita GDP). Although household expenditure and GDP are conceptually different, there is likely to be a high degree

of correlation in the changes exhibited by both. Therefore, it could be tentatively argued that our empirical results are in broad accord with the 15% decrease in per capita GDP over seven years of war reported by Collier and Hoeffler (1998) or the estimates recorded by Knight, Loayza, and Villanueva (1996) suggesting a similar effect.

The ATT estimate based on the alternative treatment measure (i.e., whether or not any members of the household were war victims) is reported in column (3) of Table 2.4. In contrast to the chiefdom-based exposure measure, we cannot compute a difference-in-difference effect given the absence of a baseline for this measure. The ATT estimate confirms that being in a household which was directly and adversely affected by the civil war induces a reduction in per capita household expenditure of about 34%, on average, relative to comparable households unaffected by the conflict. This is larger in absolute terms than the corresponding ATT estimate reported for the same metric using the conflict exposure measure. However, as noted by Bellows and Miguel (2009), an important limitation of the war victimhood data from the two more recent surveys is their self-reported nature. The responses are thus prone to bias and potential over-reporting. In particular, the size of the treatment groups reported for these measures in Table 2.4 suggests considerably higher victimisation rates than are actually implied in the conflict exposure data. This may reflect respondents using a wider definition of what constitutes their households (e.g., by including extended family members when framing responses). Nevertheless, the strong and statistically significant effects for both definitions point to a pronounced negative relationship between conflict and household welfare.

Our attention now turns to the poverty outcome measure. Again, on the basis of the matched households, the point estimate for the differential in poverty rates in 1989 suggests lower poverty incidence in the conflict zones than in the non-conflict zones prior to the outbreak of

hostilities. However, there is no statistical difference in average poverty rates at the baseline in 1989 between what subsequently became the conflict and non-conflict zones (see Table 2.4). The absolute value of the t-ratio is 1.42 with a corresponding prob-value of 0.16. The short-run difference-in-difference estimate, reported in column (2) of Table 2.4, reveals that the household poverty rate in Sierra Leone increased by about 16 percentage points as a direct consequence of the conflict. The ATT estimate based on the alternative war victimhood treatment measure (see column (4) of Table 2.4), suggests an increased poverty rate for conflict-affected households of about 21 percentage points compared to their matched control group counterparts. Again, both measures indicate substantial increases in household poverty rates in the immediate aftermath of the conflict. In addition, the estimates reported in Table 2.4 are similar to the findings of Justino and Verwimp (2008), who reported a 20-percentage point increase in the poverty rate in the immediate aftermath of the Rwandan genocide.

The ATT and causal estimates over the longer period are also presented in Table 2.4 and relate to 2011 (i.e., ATT_2 and D-i-D_2). The coefficient of the ATT effect, approximately 10 years after the end of the war, is still negative but smaller in absolute magnitude when using the conflict exposure measure. The estimated long-run ATT effect suggests an 8.5% per capita household expenditure penalty for those households in chiefdoms exposed to conflict and protracted rebel occupation during the war compared to matched households in the control group chiefdoms (see column (1)). However, the difference-in-difference (D-i-D_2) estimate between 2011 and pre-war 1989 reveals a statistically significant effect of the civil war on household welfare, with the estimated adverse effects of conflict remaining stubbornly high well after the conflict's end (i.e., $[e^{-0.2533} - 1]\times 100 = -22.4\%$). Further, although there is evidence of a slight decline in the poverty rate, it remains about 14 percentage points higher with respect to the same baseline comparison.

The empirical ATT estimates for the alternative treatment measure based on whether the household contained war victims or was directly affected by the conflict in other ways yields a more nuanced set of results over the longer term. For instance, the estimated ATT in column (3) of Table 2.4 is positive 10 years after the end of the civil war, and the poverty rate in column (4) of the same table is over five percentage points lower. The point estimates for the average treatment effects are small in magnitude, though both are found to be statistically significant. Therefore, households that incurred conflict-related loss or damage do not appear to have endured a long-term negative legacy in terms of either welfare metric – indeed the opposite appears to be the case.

This is in contrast to what is found using the exposure measure where legacy effects of conflict are seen to persist over the 10-year period of analysis. A possible and very tentative conjecture is that the negative impacts of these war-related effects have been mitigated by the targeted support provided to war victims by both government and non-government agencies. It is possible that the reparation programme introduced by the government in 2009 might have contributed to an attenuation of the negative effects of the conflict on household welfare.[4]

However, this remains a suggestive rather than a compelling account and one that clearly requires further empirical investigation. In addition, the caveats raised earlier regarding the self-reported nature of the responses used in the construction of this treatment measure remain

[4] A total of 21,700 war victims received compensation payments in the first year of the reparation programme. A permanent monthly pension adjusted for inflation was also introduced to ensure continued basic support for war victims. A comparison between the 2011 ATT estimates and those for 2003 provides a potential basis for a suggestive intention to treat analysis around the policy interventions introduced in 2009. If interpreted thus, the programme appears to exert a substantial effect on the welfare of war victim recipients. However, given the period over which the comparison is undertaken and concerns about the self-reported nature of the responses (particularly those for 2011 which may be subject to greater recall bias than for the earlier post-war year), it would be erroneous to attribute all of the welfare improvement to this programme.

apposite, with the average victimisation rate reported by households in 2011 inordinately high. Therefore, the empirical evidence here demands a high degree of interpretational caution.

Table 2.4 Average Treatment on the Treated Effects of Conflict on Welfare Metrics

	Conflict Exposure		**Conflict Events**	
	Log per capita expenditure (1)	Poverty Rate (2)	Log per capita expenditure (3)	Poverty Rate (4)
1989(ATT_0)	0.1636	-0.0882	-	-
	(0.1002)	(0.0622)	-	-
2003(ATT_1)	-0.1674***	0.0728***	-0.4187***	0.2099***
	(0.0507)	(0.0142)	(0.0378)	(0.0181)
2011(ATT_2)	-0.0897**	0.0491***	0.0785***	-0.0534***
	(0.0365)	(0.0127)	(0.0157)	(0.0141)
D-i-D_1(ATT_1-ATT_0)	-0.3331***	0.1610***	-	-
	(0.1122)	(0.0638)		
D-i-D_2(ATT_2-ATT_0)	-0.2533***	0.1373***	-	-
	(0.1066)	(0.0634)		
Sample 1989:				
Treated	1167	1167	-	-
Control	2272	2272	-	-
Sample 2003:				
Treated	1666	1666	2460	2460
Control	2036	2036	1237	1237
Sample 2011:				
Treated	2591	2591	5051	5051
Control	4172	4172	1631	1631

Notes to Table 2.4: Bootstrapped standard errors with 250 replications in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

2.8 Robustness Checks

Sierra Leone's capital Freetown was heavily protected by national and international forces during the war and so provided a relatively safe environment within which economic activity continued in a largely uninterrupted fashion. During the conflict, it was the centre of government and many non-governmental institutions engaged in either military or relief activities. Therefore, it is arguable that the economic opportunities in Freetown would have been different from the rest of the control group within the country because of the conflict. Therefore, this creates the potential for a downward bias in our empirical causal estimate. In order to address this issue, we re-do the analysis excluding data for Freetown from the control

group post-conflict. The results of this exercise are reported in Table A2.7 of Appendix 1. The core finding of the exercise is that the key ATT and difference-in-difference estimates are not materially altered by the exclusion of Freetown from the analysis.

The intensity of the civil war varied across chiefdoms and conflict years, leading to some movement of the civilian population. Therefore, as noted earlier, there may be potential spill-over effects due to voluntary migration and forced displacement. This would be particularly acute if movement between control and treatment zones were sizeable in nature. However, although migration and displacement may have been sizeable overall, the patterns reported in the SLIHS data from 2003 suggest that movement was largely confined to within the relevant treatment and control groups rather than between these two groups. Movement between the conflict and non-conflict areas accounted for 3% of total movement according to the survey data for 2003. The exclusion from the analysis of households that were subject to movement across the treatment and control boundaries does not alter the key short-run estimates reported in Table 2.4.

In addition, household displacement during the civil war may undermine the interpretation of our long-term empirical estimates. The results could be driven by returnee contributions to socio-economic activity. The 2004 NPWJ report indicates an estimated two million Sierra Leoneans were displaced during the civil war. This accounted for over one-third of the Sierra Leone population in 2004 (Statistics Sierra Leone, 2004 Population and Housing Census report). However, displacement was mostly internal, as neighbouring Liberia was also undergoing civil war and the border to the north was heavily guarded by the Guinean military, deterring entry to the country. A self-reported question on whether a household was displaced due to the civil war was asked in the 2003 SLHS. Households displaced during the civil war

accounted for 7% of the total households surveyed. This percentage is clearly not representative of the general displacement pattern. However, if we drop the relevant 7% from our short-term analysis, the core results are not significantly altered from the results in Table 2.4.

It was noted earlier that the baseline survey from 1989 is comprised of data drawn from only 64 of Sierra Leone's 152 chiefdoms, while the post-conflict data are drawn from all 152 chiefdoms. Therefore, the analysis is re-done restricting the data (both pre-conflict and post-conflict) to the original 64 chiefdoms. Although the short-run point estimates are larger in absolute terms using the restricted data, the same pattern of effects emerges as in Table 2.4. In addition, the long-run point estimates are broadly similar to the corresponding estimates from Table 2.4. Overall, the core empirical findings reported appear robust with the use of data restricted to the originally used 64 chiefdoms in the 1989 survey. The relevant ATT and difference-in-difference estimates for this exercise are reported in Table A2.8 of Appendix 1.

As a final robustness check a placebo test is implemented. This involves randomly assigning half the chiefdoms to a pseudo-treatment group and the other half to a pseudo-control group. This random assignment exercise is replicated 40 times for each of the three years, with the ATTs computed for each exercise. The averages of the ATTs are reported in Table A2.9 and the key focus of interest relates to the average ATTs for the two post-conflict years. In neither year are the ATTs found to be statistically significant. This suggests that the key findings of this study reflect the impact of a systematic process on household welfare mediated through the conflict treatment variable defined on the basis of conflict intensity and rebel occupation.

Finally, it is worth noting that the empirical work of Bellows and Miguel (2009) on war and collective action in Sierra Leone reported no evidence of an adverse effect of the conflict on

household expenditure in 2003. However, the authors used data aggregated at chiefdom level rather than at the level of the individual household and restricted their analysis to the 64 chiefdoms from the 1989 survey. The estimates reported in this study are clearly in conflict with those of Bellows and Miguel (2009). Their empirical analysis may be subject to a combination of aggregation bias and regression model over-parameterisation. In contrast, we believe the data and empirical approach adopted in the current study is not subject to either of these limitations and provides more meaningful insights on the effects of conflict on household welfare in Sierra Leone in both the short and long runs.

2.9 Conclusions

This chapter investigates the effect of the Sierra Leone civil war on household welfare using household expenditure data and poverty rates. The study contributes to a sparse literature on the impact of the Sierra Leone conflict on selected socio-economic outcomes. Our analysis differs in terms of empirical methodology and research objectives from earlier work undertaken in this area. It uses household-level data and focuses on the impact of the conflict on household welfare outcomes rather than on social, political, behavioural and firm level outcomes – themes that have featured more prominently in the conflict research agenda for this country to date.

The study uses three-household level surveys in conjunction with geographical (i.e., chiefdom-level) data on the conflict and finds that households in the conflict and rebel-occupied zones experienced a sharp reduction in per capita household expenditures of about 28% in the short-run. The civil war is also found to have increased the household poverty rate by about 16 percentage points over the same period. The magnitude of these estimates is broadly comparable with the research findings for other countries and regions where the immediate effects of conflict on economic activity have been studied. The explanations as to why conflict-

affected and rebel-occupied areas experience a reduced level of welfare are likely to be rather prosaic in nature. These relate to the fact that it takes an economy longer to recover from the destruction inflicted by such a brutal conflict. This is due to the erosion of national institutions and trust, the depletion of physical and human capital, damage to infrastructure, the disruption of social and transportation networks, and the breakdown in the functioning of product and other markets.

The long-run empirical analysis using conflict exposure measures suggests a glacially slow recovery in household expenditure, with a conflict penalty persisting approximately 10 years after the end of the civil war, and poverty rates also remaining stubbornly high. The less than positive long-run outcomes obtained using the chiefdom exposure measure may reflect the fact that the adverse structural effects of conflict at the local level take time to erode. In particular, limited government resources restrict the level of infrastructural investment available to mitigate the legacy effects of the conflict, and the findings also possibly reflect the absence of a systematic regional development policy.

In contrast, the empirical analysis using a treatment measure based explicitly on household war victimhood suggests no long-term negative impacts. Indeed, it suggests modest improvements in household expenditure and accompanying reductions in poverty rates for those households that self-report being directly affected by the conflict. Sierra Leone's reparation programme for war victims, introduced in 2009, was configured to empower war victims economically and to provide them with skills to enhance their livelihoods. The implementation of such programmes for war victims potentially softens the harsher channels through which conflict may impact household welfare. It may be the case that the finding reported here, suggesting improvements in household welfare over the longer period using this treatment measure,

partially reflects the beneficial role of this programme. However, it is also acknowledged that this measure may be subject to response bias with recall bias over the longer period, which is a potentially salient issue here. Therefore, a high degree of interpretational caution is justified with regard to the findings based on these victimhood data.

Further, it is worth noting that in the Sierra Leone conflict, the effects of the war were not simply confined to those localities directly impacted by the conflict through rebel occupation and the incidence of military engagements. Thus, it is reasonable to assume that all areas of Sierra Leone are likely to have suffered from the conflict to one degree or another. Given the estimates reported here only compare the conflict to the no conflict chiefdoms, they are likely to under-estimate the overall impact of the conflict on Sierra Leone. Therefore, it is arguable that these estimates possibly represent a set of lower bound estimates and this should be borne in mind in interpretation.

Finally, it is acknowledged that the identification strategy used in this study to estimate the causal effect of the civil war on household welfare using the conflict exposure measure is not the cleanest, and purists could legitimately challenge the authenticity of the causal effects reported in this study. As noted by Ruhm (2019), there is a trade-off in applied work, particularly when restricted to using observational data, between clean identification of key estimates and the need to seek answers to important questions (like the household welfare impact of the Sierra Leone civil war). Even if purists are unconvinced and argue that the evidence presented here is largely descriptive in nature, the description points persuasively to a sizeable impact of conflict on household welfare in the immediate aftermath of the war. At the very least, this study should be interpreted as adding to a body of evidence on the impact of conflict on household welfare in Sierra Leone.

Appendix 1

Figure A 2.1: Sierra Leone Conflict Map (Rebel Headquarters)

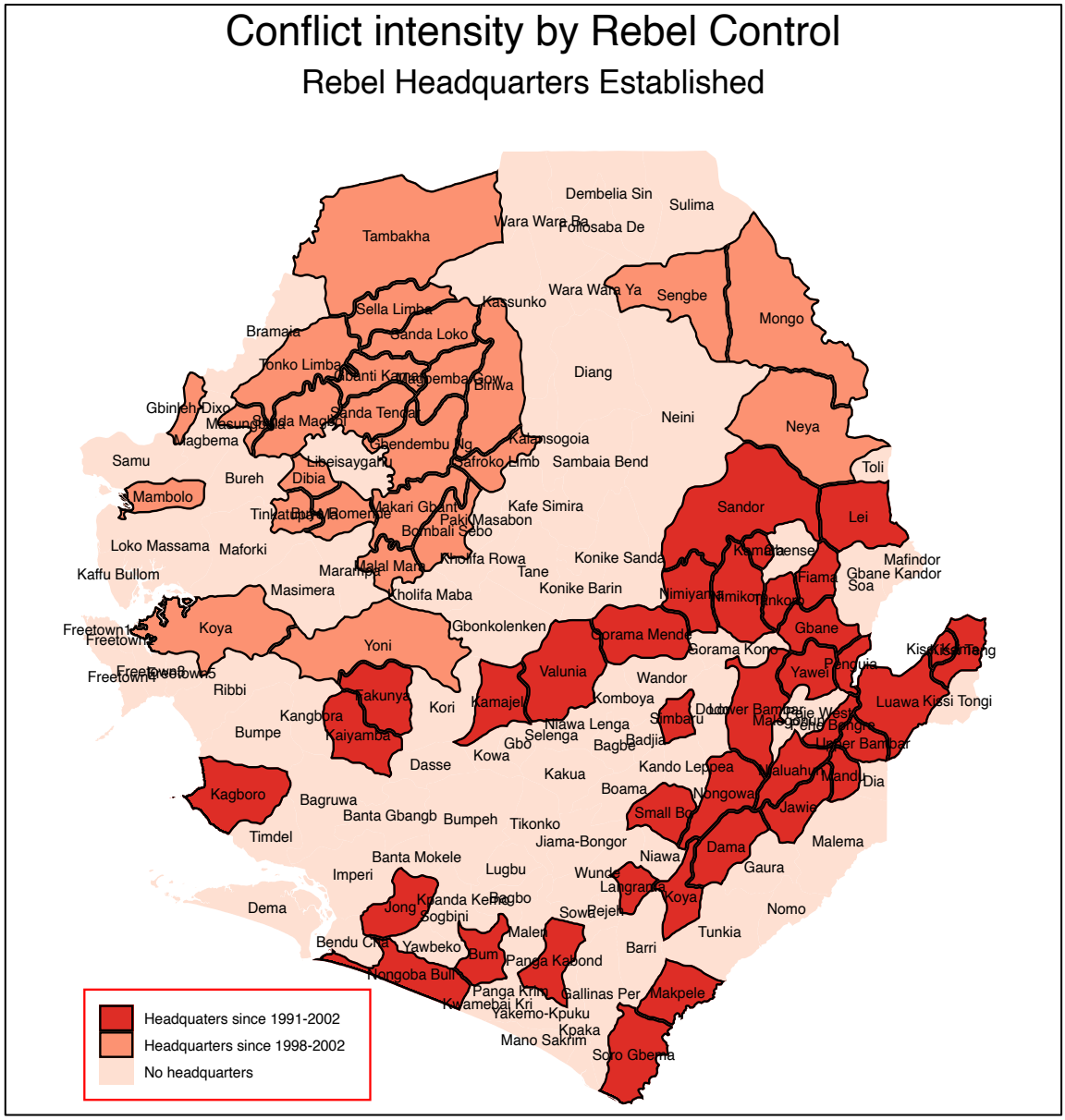


Table A 2.1: Chiefdom Allocation to Treatment and Control Groups across the Three Survey Years

Years in Survey	Chiefdoms in Treatment Group	Chiefdoms in Control Group
1989, 2003, and 2011	**Eastern Regions:** Biriwa Bombali Shebro Bum Dama Fiama Jawie Mandu Lower Bambara Nimikoro Njaluahun Nongowa Simbaru Small Bo Tankoro **Northern Region** Gbanti-Kamaranka Gbendembu Ndowahun Gbinleh Dixing **Southern Region:** Jong Kaiyamba Panga Kabone Valunia Bumpeh Fakunya **Northern Region:** Koya Magbema Makari Gbanti Malal Mambolo Masungbala Sanda Loko Sella Limba	**Eastern Region:** Malegohun Gbense Gorama Kono **Northern Region:** Paki Masabong Samu Dembelia Sinkunia Follosaba Dembelia Sulima Wara Wara Yagala Kaffu Bullom Lokomasama Maforki Marampa Gbonkolenken Kholifa Mabang Kunike Barina **Southern Region:** Bagbo Baoma Jaiama Bongor Kakua Komboya Tikonko Imperi Kpanga Kemo Bumpeh Upper Banta Barri **Western Area** Mountain York Rural Waterloo Central 1 Central 2 East 1 East 2 East 3 West 1 West 2 West 3
2003 and 2011 only	**Eastern Regions:** Kissi Kama Luawa Penguia Yawei Gorama Mende Langrama Gbane Kamara Lei Nimiyama Sandor **Northern Region:** Safroko Limba Sanda Tendaren	**Eastern Regions:** Kissi Tongi Kpeje Bongre Kpeje West Dodo Gaura Kandu Lekpeama Nomo Tunkia Wandor Mafindor Soa Malema Nomo Niawa

	Tambakka Tonko Limba Mongo Neya Sengbe Bureh Kasseh Buya Romende Dibia Sanda Magbolontor **Southern Region:** Jong Nongoba Bullom Kamajei Kongbora Makpele Pejeh Soro Gbema	**Northern Region:** Libeisaygahun Magbaimba Ndorhahun Kasunko Nieni Wara Wara Bafodia Masimera Kafe Simira Kalansogoia Tane Paki Masonbong Braiama Diang **Southern region:** Bumpe Ngawo Niawa Lenga Bendu Cha Sogbini Bagruwa Kagboro Kowa Lower Banta Timdale Gallinas Peri Mano Sakrim Yakemo Kpukumu Krim Badjia Bagbo Wunde Kwamebi Krim- Beduma Sittia- Yonni Yawbeko- Talia Dasse Kori Ribbi Kpaka Sowa

Table A 2.2: Summary Statistics of Outcome Variables by Conflict Events

	2003		2011	
	Conflict Mean	Non-conflict Mean	Conflict Mean	Non-conflict Mean
Log per capita expenditure	13.41	13.88	13.93	14.15
	(0.77)	(0.95)	(0.50)	(0.68)
Poverty Rate	0.81	0.59	0.60	0.45
	(0.39)	(0.49)	(0.49)	(0.50)
Sample	2377	1319	4041	2722

Notes to Table A2.2: standard deviations in parenthesis.

Table A 2.3: Pre-war (1989) Covariate Balancing Tests Using Conflict Exposure Treatment

	Treated	Control	%bias	t-value	p>t	Variance Ratio
Age of head	42.87	43.01	-1.20	-0.48	0.63	0.98
Age of head sq	1958.50	1971.20	-1.10	-0.45	0.65	1.07
Head male	0.86	0.87	-2.60	-0.98	0.33	0.99
Head cohabiting	0.93	0.93	-0.90	-0.34	0.73	1.02
Dependency ratio	0.90	0.88	1.90	0.84	0.40	1.13
Urban	0.34	0.36	-3.20	-1.17	0.24	1.00
Head prim educ	0.57	0.59	-4.40	-1.55	0.12	0.97
Head higher educ	0.43	0.41	4.50	1.55	0.12	0.97
Household size	5.41	5.44	-0.70	-0.28	0.78	1.01
Household size sq	41.52	41.65	-0.20	-0.09	0.93	1.07
Head prim educ × urban	0.19	0.19	-1.20	-0.44	0.66	0.98
Head male × urban	0.29	0.31	-2.90	-1.06	0.29	0.99

Notes to Table A2.3: * if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2];
** if 'bad', i.e. variance ratio <0.5 or >2.0

Table A 2.4: Post-war (2003) Covariate Balancing Tests using Conflict Exposure Treatment

	Treated	Control	%bias	t-value	p>t	Variance Ratio
Age of head	46.80	46.66	1.00	0.29	0.77	0.99
Age of head sq	2386.00	2374.70	0.80	0.22	0.82	0.99
Head male	0.82	0.83	-4.90	-1.47	0.14	0.87
Head married	0.84	0.86	-5.10	-1.58	0.11	1.11
Dependency ratio	0.95	0.94	1.50	0.44	0.66	1.10
Urban	0.30	0.30	-0.80	-0.24	0.81	0.99
Head prim educ	0.09	0.09	0.30	0.09	0.93	1.01
Head higher educ	0.02	0.02	0.20	0.06	0.95	1.01
Household size	6.28	6.25	1.30	0.40	0.69	1.01
Head prim educ × urban	0.04	0.04	0.70	0.22	0.83	1.04
Head male × urban	0.25	0.25	-0.60	-0.17	0.86	0.98
Dependency ratio × urban	0.30	0.30	-0.20	-0.08	0.94	1.08
Household size sq	46.28	45.75	1.20	0.38	0.71	1.01
Household size × urban	1.87	1.90	-0.80	-0.24	0.81	0.99
Head married × urban	0.25	0.26	-1.60	-0.46	0.65	0.98
Head a Muslim	0.80	0.80	-0.10	-0.02	0.99	1.00
Head from Temne tribe	0.24	0.24	0.30	0.07	0.94	1.00

Notes to Table A2.4: * if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2];
** if 'bad', i.e. variance ratio <0.5 or >2

Table A 2.5: Post-war (2011) Covariate Balancing Tests using Conflict Exposure Treatment

	Treated	Control	%bias	t-value	p>t	Variance Ratio
Age of head	45.70	46.05	-2.40	-0.87	0.38	1.05
Head primary educ	0.07	0.06	0.90	0.36	0.72	1.05
Head higher educ	0.05	0.04	1.60	0.70	0.48	1.09
Head male	0.73	0.74	-2.20	-0.78	0.44	1.03
Head married	0.81	0.82	-2.40	-0.92	0.36	1.03
Dependency ratio	1.08	1.09	-0.80	-0.30	0.77	1.01
Household size	5.65	5.66	-0.40	-0.17	0.86	1.11
Age of head sq	2304.40	2320.10	-1.10	-0.38	0.70	1.06
Urban	0.17	0.17	-0.20	-0.09	0.93	0.99
Dependency ratio × urban	0.19	0.19	-0.40	-0.19	0.85	1.04
Head married × urban	0.12	0.12	-0.30	-0.12	0.91	0.99
Head male× urban	0.11	0.12	-0.80	-0.36	0.72	0.97
Head prim educ × urban	0.02	0.02	-0.10	-0.06	0.96	0.99
Household size × urban	0.96	0.94	0.50	0.22	0.82	1.01
Household size sq	37.98	37.45	1.30	0.54	0.59	1.11
Head a Muslim	0.78	0.78	-1.10	-0.40	0.69	1.02
Head a Muslim × urban	0.12	0.12	0.00	0.01	0.99	1.00

Notes to Table A2.5: * if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2];
** if 'bad', i.e. variance ratio <0.5 or >2

Table A 2.6: Pre-war and Post-war Balancing Property Diagnostics for Conflict Exposure

Years	Pseudo R^2	LRT Chi-squared	p>chi2	Mean Bias	Median Bias	B	R	%concern	%bad
1989: Unmatched	0.038	105.55	0.00	18.20	21.80	43.10*	2.52*	33.00	8.00
Matched	0.002	11.20	0.43	2.10	1.60	9.10	1.24	0.00	0.00
2003: Unmatched	0.149	137.95	0.00	18.40	14.00	97.6*	0.73	59.00	12.00
Matched	0.003	19.84	0.283	2.40	2.10	13.00	1.46	0.00	0.00
2011: Unmatched	0.127	781.26	0.00	25.00	11.30	89.70*	1.03	35.00	24.00
Matched	0.001	10.79	0.867	1.20	0.80	7.40	1.15	0.00	0.00

Notes to Table A2.6: * if B>25%, R outside [0.5; 2]

Table A 2.7: Average Treatment on the Treated Effects of Conflict on Welfare Metrics (excluding Freetown from the post-conflict data)

	Conflict Exposure		Conflict Events	
	Log per capita expenditure (1)	Poverty Rate (2)	Log per capita expenditure (3)	Poverty Rate (4)
1989(ATT_0)	0.1636	-0.0882	-	-
	(0.1002)	(0.0622)	-	-
2003(ATT_1)	-0.1370***	0.0562***	-0.4187***	0.2099***
	(0.0505)	(0.0134)	(0.0378)	(0.0181)
2011(ATT_2)	-0.0878**	0.0495***	0.0785***	-0.0534***
	(0.0382)	(0.0135)	(0.0157)	(0.0141)
D-i-D_1(ATT_1-ATT_0)	-0.3006***	0.1444***	-	-
	(0.1122)	(0.0636)		
D-i-D_2(ATT_2-ATT_0)	-0.2514***	0.1380***	-	-
	(0.0125)	(0.0636)		
Sample 1989:				
Treated	1167	1167	-	-
Control	2272	2272	-	-
Sample 2003:				
Treated	1666	1666	2460	2460
Control	1916	1916	1237	1237
Sample 2011:				
Treated	2591	2591	5051	5051
Control	4065	4065	1631	1631

Notes to Table A2.7: Bootstrapped standard errors with 250 replications in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 2.8: Average Treatment on the Treated Effects of Conflict on Welfare Metrics (based on 64 chiefdoms)

	Conflict Exposure		Conflict Events	
	Log per capita expenditure (1)	Poverty Rate (2)	Log per capita expenditure (3)	Poverty Rate (4)
1989(ATT_0)	0.1636	-0.0882	-	-
	(0.1002)	(0.0622)	-	-
2003(ATT_1)	-0.3984***	0.1402***	-0.4187***	0.2099***
	(0.0596)	(0.0186)	(0.0378)	(0.0181)
2011(ATT_2)	-0.0888**	0.0562***	0.0785***	-0.0534***
	(0.0589)	(0.0184)	(0.0157)	(0.0141)
D-i-D_1(ATT_1-ATT_0)	-0.5620***	0.2302***	-	-
	(0.1037)	(0.0625)		
D-i-D_2(ATT_2-ATT_0)	-0.2524***	0.1444***	-	-
	(0.1036)	(0.0625)		
Sample 1989:				
Treated	1167	1167	-	-
Control	2272	2272	-	-
Sample 2003:				
Treated	894	894	2460	2460
Control	1262	1262	1237	1237
Sample 2011:				
Treated	1519	1519	5051	5051
Control	2259	2259	1631	1631

Notes to Table A2.8: Bootstrapped standard errors with 250 replications in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 2.9: Average Treatment on the Treated Effects of Conflict using a Placebo in Space

	Conflict Exposure	
	Log per capita expenditure (1)	Poverty Rate (2)
1989(ATT_0)	0.0984*	-0.0536*
	(0.0420)	(0.0242)
2003(ATT_1)	0.0015	-0.0116
	(0.0049)	(0.0138)
2011(ATT_2)	0.0056	-0.0078
	(0.0405)	(0.0126)
D-i-D_1(ATT_1-ATT_0)	-0.0969	-0.0652
	(0.0422)	(0.0278)
D-i-D_2(ATT_2-ATT_0)	-0.0928	-0.0614
	(0.0583)	(0.0272)
Average Sample 1989:		
Treated	1506	1506
Control	1968	1968
Average Sample 2003:		
Treated	1894	1894
Control	1808	1808
Average Sample 2011:		
Treated	3429	3429
Control	3344	3344

Notes to Table A2.9: The chiefdoms were randomly allocated to either an artificial control or treatment group using a random number generator, and this exercise was repeated 40 times; the estimates reported are based on the average of the 40 exercises; average bootstrapped standard errors based on 250 replications for each are reported in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

3 Chapter Three - The Impact of Civil War on Inequality in Sierra Leone (Essay 2)

3.1 Introduction

It has long been acknowledged that conflict has consequences for the socio-economic indicators of the countries it affects. As widely discussed in the development literature, these adverse effects emerge from the loss of life, destruction of physical infrastructure, disruption of markets and social networks, and increased uncertainty that conflict induces. The effect of conflict on household welfare is mediated through changes in socio-economic outcomes as well as through institutional and cultural changes (see Blattman and Miguel, 2010). It can cause a paradigm shift in the socio-economic status of households in an affected country. The vulnerability of developing countries can be exacerbated and amplified through the impact of economic shocks like civil conflict, leading to increased poverty and reductions in household expenditure levels (see Essay 1 of this thesis and Justino and Verwimp, 2006). In contrast, the evidence on the impact of conflict on the distribution of household expenditure or income is somewhat limited. Thus, investigating the impact of conflict on household welfare distribution and inequality can help provide insights on the type of policies required to mitigate the adverse effects of civil conflict.

The existing literature on the relationship between inequality and conflict has largely focussed on the impact of vertical inequality (e.g., income distribution across individuals) or horizontal inequality (e.g., endowment differences across groups defined in terms of ethnicity or religion) in triggering conflict. The limited set of empirical results on the impact of inequality on conflict are mixed. The evidence suggests that vertical inequality is a less important promoter of conflict (see Collier and Hoeffler, 2004; Fearon and Laitin, 2003) compared to different forms of horizontal inequality (see Ostby, 2008). The reverse relationship, however, has attracted less

research, with the limited work undertaken to date confined to cross-country macro-level data analysis (see Bircan, Bruck, and Vothnecht 2010) suggesting that conflict in Africa – in particular civil war – increases vertical inequality as measured by country-level GDP. However, to the author's knowledge, no systematic research to date has been undertaken on the impact of conflict on household welfare inequality using micro-level data.

The civil war in Sierra Leone endured for over a decade and eventually came to an end in 2002. The objective of this research is to understand the short-term and long-term impacts of this conflict on vertical inequality as measured by distribution of household expenditure. Using three cross-sectional household-level datasets – one covering the pre-war period (1989) and two covering the post-conflict period (2003 and 2011) – we analyse the impact of the civil war on household expenditure distribution using both quantile-based measures and Gini index regression methods. It is argued that this empirical work contributes to the small volume of literature on the causal relationship between conflict and household welfare inequality.

The key finding of this paper is that conflict exerts an overall negative impact on the distribution of household expenditure, but one that is particularly deep at the top end of the distribution. In addition, the level of household expenditure inequality reduces significantly immediately after the end of the civil war by approximately eight Gini points. However, the estimated effect on inequality is found to have dissipated a decade after the end of the civil war. The potential explanation for the findings rests on the destructive strategies employed by the rebel groups towards visible high value assets like residential properties and the policy encouraged by the rebel groups' leadership of purloining (or looting) household assets.

The next section of this essay provides some background on the nature and activity of the rebel groups involved in the conflict. This is then followed by a literature review, which details the relationship between conflict and inequality, placing a particular emphasis on the distinction between vertical and horizontal concepts of inequality. This is then followed by a data section and a section outlining the empirical methodology used. The empirical results are reported in a subsequent section, which is followed by a section reporting a series of robustness checks. A penultimate section provides a discussion of the results, with a final section providing concluding remarks.

3.2 Background: The Civil War in Sierra Leone and Rebel Group Activities

As noted in Essay 1, Sierra Leone was originally constituted as a British protectorate and is bordered by Liberia to the east and Guinea to the north. The country provided for export unprocessed raw materials like agricultural products and minerals. The municipality of Freetown was used as a trading and administrative centre during the period of British rule. The country gained its independence from Britain in 1961. Since independence, economic development was uneven, and governance was marked by weak institutions and autocratic political rule by the All People's Congress (APC) party. A civil war initially started in the neighbouring country of Liberia in 1989 but Sierra Leone was vulnerable to the conflict spilling over given the prevalence of political distrust within the country (see Clapham, 2001; Keen, 2005).

The civil war eventually started in Sierra Leone in March 1991 and ended in May 2002. The war centred around brutal civilian attacks, armed battles, and two successful coups d'état. The civil war can be described with respect to three important phases. The first phase (1991-1995) includes the country's invasion by the Revolutionary United Front (RUF) from the eastern border with Liberia in 1991, led by Foday Sankoh. In 1992, a military junta group led by a military captain, Valentine Strasser, staged a coup and overthrew the ruling president. The military junta group was called the National Provisional Ruling Council (NPRC). Their leader became head of state from 1992 to 1994. The country was still experiencing unrest as the rebel groups extended their control in the provincial areas. In 1995, a ceasefire agreement between the rebel factions and the government marked the end of the first phase of the war.

The second phase (1996-1999) was initiated with the election of President Tejan Kabba in March 1996. He was affiliated with an opposition party known as the Sierra Leone People's

Party (SLPP). A second military coup d'état took place in May 1997, but the ruling party was reinstated after a few months. A period of unsuccessful negotiations with the RUF led to the junta intervention on January 6th 1999. The rebels temporarily captured part of the capital city from the control of national and international armed forces. A short and intense military exchange between the rebel and allied groups forced the rebels out of the capital by the end of the month. The final phase of the conflict (2000-2002) encompasses the peace talks, an amnesty for RUF combatants, and retirement packages for the national soldiers. The 2002 peace agreement was eventually signed in Lomé and marked the official end of the civil war.

Societies emerging from protracted violence are faced with numerous socio-economic challenges (see Sesay, 2007). An understanding of the cause(s) of violence can help in building policies to mitigate a conflict's negative effects and prevent a resurgence of unrest. Sierra Leone, prior to the civil war, was characterised by widespread popular discontent with corrupt government rule, and an unequal distribution of developmental projects and public services (see Keen, 2005; Bellows and Miguel, 2006; Raleigh and Bruijne, 2017). The country was situated at the bottom of the World Development Index in 1990, two years before the civil war (United Nations Report, 1993). The factors that animated the civil war are not clear, but there is agreement that the state's failure to provide public services and promote economic growth were significant factors (see Keen, 2005; Bellows and Miguel, 2006). The failure of the state in providing education and employment opportunities led to an increase in the willingness of the disenfranchised youth to use violent means to express their disgruntlement with the state (see Richards, 1996). Interestingly, there is no evidence to be found that the war was motivated by ethnic or religious fractionalisation (i.e., horizontal inequality). The war became more controversial as the RUF turned against the civilian population that it purported to have come to liberate and perpetrated brutal acts of killing, limb amputations, and rape. The violence was

generally gratuitous in nature and described elsewhere as senseless (see Keen, 2005). However, the lack of popular support and funding for arms and ammunition, food, and other resources impeded the rebellion.

It has been argued that if the perceived benefits outweigh the costs, then rebellion becomes an attractive option (see Collier and Hoeffler, 1998). These perceived benefits could be derived from external support or the use of personal extortive activities. The RUF and later some 'Sobels' (so called because they were government soldiers acting like rebels) engaged in exploitation techniques. The civil war saw a high proliferation of attacks on civilian wealth assets and public infrastructure. The looting of private property and other household wealth assets constituted a deliberate strategy on the part of the rebels. The leader of the RUF group, Foday Sankoh, encouraged the rebels to undertake these activities, classifying them as 'operations'. These strategies included 'operation pay yourself' and 'operation hit, run and destroy'. Sankoh instructed the RUF rebels to conduct these activities as a form of self-payment and to terrorise local communities in order to establish control and weaken opposition to rebel presence in their communities.

Agricultural activities were disrupted as the war became concentrated in agriculturally rich regions. These areas were targeted to provide food resources for the rebels. The widespread theft and killing of animals and the looting and destruction of physical assets exacerbated the poor economic conditions (see, for example, United Nation Development Program, 1995; World Food Program, 1996; Keen, 2005). The strategy was designed to depopulate resource-rich areas and resulted in the displacement and abandonment of assets and livelihoods (Keen, 2005).

As a protective measure against the rebels, local communities formed militia groups collectively known as the Civilian Defence Force (CDF). They generated support locally and gained widespread support across the country. However, during the later stages of the war, most CDF units lost discipline and eventually engaged in stealing and looting of private possessions and participated in illicit diamond mining. Thus, 'operation pay yourself' was eventually adopted by all sides during the war (see Keen, 2005). The national army and their allies' offensives against the RUF and other rebel sub-groups encouraged the rebels to use the tactic of 'hit, destroy and run' leading to further death and destruction of property and assets (see Hoffman, 2011, p. 41).

There is some evidence that the rebel groups systematically targeted public infrastructure installations, primarily in rural areas. This involved the burning down of schools, hospitals, and other public administrative units of the government. However, public infrastructure in urban centres was protected by national and international peacekeeping forces and was largely unaffected by this strategy. As a consequence, however, the targeting strategy switched from public to private, unprotected properties (see Keen, 2005; Sesay, 2007). Raleigh and De Bruijne (2010) reported high levels of lootings of private property in areas controlled by the rebel groups compared to those controlled by government forces.

In combating and suppressing the rebels, strong measures were implemented by the government of Sierra Leone. This helped prevent the insurgents from controlling all parts of the country. The western area, and some chiefdoms in the north, were protected by a coalition of international forces. The coalition included the United Nations, the British Army, Economic Community of West African States Monitoring Group (ECOMOG) forces, and the privately-run armed group known as Executive Outcomes. This military presence and the poor

interconnections provided by road networks to neighbouring chiefdoms restricted the activities of the insurgent groups to certain areas. In particular, the defeat of the rebel forces in Freetown initiated a brutal and desperate reaction by the rebels, including widespread rape and looting. The reversal of the rebels' effort to control and impose authority was usually followed by greater destruction of life and property.

In 2002, a peace agreement was signed in Lomé, marking the official end of the war. The recovery process was underpinned by post-war support from international organisations like the World Bank, the United Nations Development Program, USAID, the UK's Department for International Development (DfID), and a variety of non-governmental organisations (NGOs). As part of the agreement signed in Lomé, and following an act of the Sierra Leone Parliament, a Truth and Reconciliation Commission (TRC) was established. As noted in Essay 1, the TRC report (see Conibere, Asher, Cibelli, Dudukovich, Kaplan, and Ball 2004) was released in October 2004. The report, based on an evaluation of the insurgency and conflict-related activities that had occurred during the war, outlined a set of recommendations for post-conflict recovery. One of the recommendations was the provision of a reparation programme for war victims who fell under the following categories: war-related amputations, sexual violence, war wounded, child victims, and war widows. International financial aid and other developmental support came as a response to the post-conflict recovery strategies set by the government of Sierra Leone.

3.3 Literature Review on Conflict and Inequality

The impact of conflict on inequality is difficult to cleanly identify, as the relationship may be subject to reverse causality. For example, there is a strand of literature, using cross-country data, which suggests that the resultant impact of conflict is to increase inequality (see Bircan, Bruck, and Vothnecht, 2010). In contrast, a more widely held view within the literature that reverses the direction of causality asserts that inequality can act as a catalyst for conflict insurgence (see Stewart, 2008). However, the provenance of the inequality is found to be important, with horizontal inequality seen as providing a more significant driver for conflict compared to vertical inequality. The focus of this essay is on the relationship between conflict and vertical inequality, with this review assessing the potential for a relationship to run in either direction. The first sub-section of this review concentrates on the theoretical relationship between conflict and inequality and reports the limited empirical evidence on this theme. The second sub-section reviews the reverse direction and discusses the supportive empirical literature around this theme.

The concept of vertical economic inequality has generally been defined using a measure of disparity in income. This can be evaluated among individuals or groups within a society. However, other welfare indicators of inequality based on household expenditure patterns reflect underlying patterns in income inequality and better capture the inequality inherent in permanent income. This part of the review focuses on the main theoretical arguments and the empirical findings on the role of inequality in determining conflict.

The key factors that lead to civil war have been broadly addressed by the grievance theory popularised by Collier and Hoeffler (2004). The determinants of inequality in an economy can be explained by reference to socio-economic and political indicators. Inequality can prevail in

an economy given the presence of socio-economic deprivation, political exclusion, and favouritism towards certain elite groups in society. Economic grievance in the form of protracted income inequality is a mechanism through which inequality can fuel conflict. The conflict is motivated by a bid to demand political change and redistribution. The argument is that persistent inequality can lead to grievance among the disadvantaged population. If there are no meaningful reforms and state-led repression is prevalent, the aggrieved section of society may turn to and deploy violent options.

A common measure of vertical economic inequality within a society is the Gini coefficient, which captures the extent to which the observed income across households deviates from equality. Higher values indicate higher inequality. The conventional Gini coefficient can be adopted to define disparity in the distribution of a variety of different welfare measures including income and household expenditure. The empirical literature that uses the Gini coefficient as a proxy for vertical economic inequality has found no evidence of a relationship with conflict insurgence (see Fearon and Laitin, 2003; Collier and Hoeffler, 2004). However, the absence of statistical significance has been attributed to poor quality data and aggregation bias related to the use of country-level data as the primary unit of observation. In contrast, inequality measures based on horizontal inequality that take into consideration social class, caste, and ethnic differences have provided evidence that inequality of this kind provides incentives for violent revolution (see Boix, 2008; Acemoglou and Johnson, 2006). The role of grievance stemming from vertical inequalities as a catalyst of conflict has found little support in the conflict literature (see Gurr, 1968; Davies, 1962; Muller and Sleigson, 1987; Collier and Hoeffler, 2004). Vertical inequality (either individual or group) motivating grievance finds little empirical support in the conflict insurgence literature. The resource curse theorists like

Tilly (1978) and Muller (1972) have strongly criticised such individual-level frustrations as plausible drivers for political action or civil war.

However, the grievance-based theory, despite its shortcomings, is still far from being discarded in the literature. Stewart (2008) presents a neater way to conceptualise the relationship between group-based vertical inequality and conflict. The author hypothesises that conflicts usually involve a contest between organised individuals or groups, on the one hand, and the government or *status quo* on the other. This group-based inequality is termed horizontal inequality in this conceptualisation. The important contrast between vertical inequality and horizontal inequality is that the latter measures inequality across groups defined in terms of social class, ethnicity or religion. Specifically, Stewart (2008) defines horizontal inequality as disparities across economic, social, and political dimensions, or the absence of cultural esteem between defined groups. An ethnic group-based perception of being deprived or excluded from accessing skills, resources, social status, or an equal distribution of political representation may lead to conditions within which conflict insurgency can occur (Tilly, 2007; Gamson, 1992; Buhaug, 2010). Thus, these dimensions of inequality tend to be a more potent catalyst of conflict than inequalities measured exclusively along a vertical dimension (e.g., household income or expenditure).

Horizontal inequality in the grievance-conflict theory has provided a plausible mechanism through which grievance can potentially determine conflict. The horizontal inequality literature has focused on ethno-political and economic grievances (see Gellner, 1983). This has motivated the work of Sambanis (2001) and Fearon and Laitin (2003), who used cross-country analysis to investigate these propositions. The evidence is mixed, with the empirical work exploring the relationship between ethnic diversity or polarisation and conflict. Some

researchers find a positive relationship (e.g., Sambanis, 2001), while others find no evidence primarily due to the fact that fractionalisation is too broad a proxy to capture ethnic discontent (e.g., Fearon and Laitin, 2003; Collier and Hoeffler, 2004).

However, and of direct relevance to this research, it is generally acknowledged that the civil war in Sierra Leone was not motivated by religious or ethnic identity issues (Fanthorpe, 2005; Dupuy and Binningsbø, 2008; Humphreys and Weinstein, 2006). Hence, it is difficult to argue that horizontal inequities provided any motivation for the conflict. The foregoing discussion emphasises that the literature suggests that vertical inequality, as measured by the Gini coefficient, does not fully capture all the relevant dimensions of disparities within society. Nevertheless, the Gini coefficient is very important in conveying the magnitude of individual-level welfare disparities and may be a key indicator in understanding other facets of inequality within a society.

The emergence of the greed versus grievance theory in the conflict insurgence literature (Collier and Hoeffler, 1998) has provided a basis for discussion about what are the significant catalysts of conflict. Collier and Hoeffler (2004) found the greed-based model to provide the most likely explanation for civil war insurgence and resurgence. The investigation of grievance as a driver of conflict opened a debate that remains ongoing. The literature has centred around ethno-political and economic deprivation in an attempt to understand the relationship between grievance and civil war, but has found no statistically significant relationship (Fearon and Laitin, 2003; Collier and Hoeffler, 2004).

Using the horizontal inequality concept, Ostby (2011) undertook a cross-sectional study of 36 developing countries using national household data from the various Demographic and Health

Surveys. The results supported the argument that conflict is positively determined by economic and ethnic polarisation (i.e., horizontal inequality) rather than income inequality (i.e., vertical inequality). The author concluded that horizontal inequalities may enhance grievance and motivate group cohesion among relatively deprived groups within a society.

Cederman, Weidmann, and Gleditsch (2011) concluded that horizontal inequality between politically relevant ethnic groups can promote ethno-nationalist conflict. The authors employed geo-coded data to construct global spatial wealth estimates and found that highly unequal societies engage in conflict more often than those with less wealth inequality. Buhang, Cederman, and Gleditsch (2014) reported country-level computations of both vertical and horizontal inequality indices. They asserted that common indicators like the Gini coefficient (a proxy for vertical inequality) failed to adequately capture aspects of political exclusion and economic inequality that can lead to conflict. In contrast, group-based inequality indices that explicitly considered political discrimination and wealth differentials provided better predictors for the onset of civil war than the more conventionally used inequality measures.

Hegre, Ostby, and Raleigh (2009) debunked the mainstream findings that economic inequality between individuals does not increase the risk of conflict. Their study provided country-level analysis using information on group-based vertical inequality metrics. Using household and conflict data for Liberia, the authors investigated the link between local levels of poverty and the location of actual fighting during the conflict. Their empirical methodology used spatial interpolation and information about the geographical location of respondents to generate local-level variables for absolute and relative wealth using data drawn from household assets. The study revealed that conflict events took place in wealthy regions. At the end of the civil war, due to the destruction of assets, the conflict-affected locations became poorer. Their findings

provide some support for the 'opportunity' explanation for armed conflict emphasised by Collier and Hoeffler (2004) rather than for the relative 'deprivation' explanations. The research revealed evidence of combatants targeting high-value 'lootable' goods, either in the form of natural resources or consumer goods. The rebel strategy encouraged retaliation against the ruling community in the form of shootings, looting property, and burning houses (see Duyensteyn, 2005; Reno, 1999).

The foregoing has shown that the recent literature provides some empirical evidence that political and economic horizontal inequalities increase conflict risk. This provides justification for the view that the onset of conflict may be grievance-based. However, the country level evidence is more nuanced, and it should be noted that the civil war in Sierra Leone was not driven by fractionalisation or ethnic grievance. This view is confirmed by a statistical analysis of the documented human rights violations, which reveals that no ethnic group was disproportionately represented among RUF victims (see Conibere et al., 2004). There is also no evidence that levels of civilian abuse were higher when a particular armed faction and the local community were predominantly from different ethnic groups (see Humphries and Weinstein, 2006). Hence, horizontal inequality might not be an important factor in understanding the impact of inequality on the civil war. The factors driving the conflict in Sierra Leone are likely to be more prosaic. The country was characterised as one of the poorest in the world prior to the onset of the conflict and was ranked bottom of the World Development Index in the late 1980s. In addition, high levels of corruption and the absence of effectively functioning institutions created stronger conditions for vertical income inequality.

There is no clear empirical evidence regarding the presence of horizontal inequality in Sierra Leone prior to the civil war. The methods through which the rebel groups perpetrated their

activities were largely based on acquisitive motives, with some evidence that their activities focussed on high-value, wealthy targets. This was most evident in the confrontation with the national and international armed forces over alluvial diamond access and the scale of household looting in occupied areas (see Cederman et al., 2011; Keen, 2005).

The foregoing empirical studies provide mixed results on whether vertical inequality significantly impacts the emergence of conflict. The conceptualisation of the potential impact of conflict on inequality, on the other hand, has been limited and less discussed in the existing literature. In particular, the impact of conflict on inequality defined along a vertical dimension has attracted less research interest in the literature but is critical to the design of post-conflict recovery policies. This part of the review deals with the theory and the empirical literature on the potential impact of conflict on inequality.

An interesting line of argument regarding the relationship between conflict and inequality has recently emerged in the work of the economic historian Walter Scheidel (2017) in his book, *The Great Leveler.* Scheidel extensively documented the potential impact of conflict on income inequality, drawing on evidence from both recent and distant history. The author provided analysis supporting the interpretation of conflict (among other events) as a mechanism through which inequality can be levelled out within a country or region.

Scheidel (2017) argued that conflict, which affects society through the destruction of capital assets and a direct assault on 'the haves', contains a strong inequality-levelling potential. The levelling outcome can be achieved through the redistribution of income from the rich to the poor or through the total destruction of wealth assets held by the rich. Levelling through total destruction can occur as a consequence of property being destroyed or looted, or through the

theft of assets from society's more affluent sections. Using the Gini coefficient in a large number of historical contexts between the period 1932-2010, Scheidel (2017) documented strong and persuasive evidence that conflict can lead to a sharp reduction in income inequality.

Conflict alters the economic structure of a country through the physical destruction of infrastructure and the disruption of markets and networks, and exerts a negative impact on welfare indicators as confirmed in the first essay of this thesis. The relational direction of conflict impacting economic inequality has been less researched and mostly limited to cross-country analysis. It should be stressed that data availability on household consumption, income, and expenditure prior to and after a conflict has posed a major challenge in empirically investigating the impact of conflict on household inequality. Thus, only a small number of studies have overcome this challenge, and it is to these that our attention now turns.

Analysing the poverty risk and the distribution of income in Bosnia and Herzegovina after the civil war there, Bisogno and Chong (2002) found contrasting differences with respect to regional variation, ethnic differences, and household characteristics. They compared poverty indices and the Gini coefficient across these three dimensions and reported a mixed set of results. There was evidence of heterogeneity in terms of inequality after the war had ended. This was attributed to the role of different factors with outcomes dependent on the extent of physical infrastructure destruction, differences in international aid flows, external trade links, and the incidence and level of remittances at the regional level. The regions or households that had endured limited infrastructure destruction, enjoyed good external links, and were recipients of aid flows and remittances exhibited a less unequal welfare distribution after the war in that country.

Ansoms (2005) provided a descriptive analysis of Rwanda's post-war growth path using cross-country evidence. Using cross-country data, the empirical methodology treated Rwanda as a special (impulse) dummy in the estimated specification. The study provided evidence of redistribution and increased household poverty rates after the Rwanda conflict. The authors calculated income elasticities across quintiles and found a disproportionately higher contraction for the poorest, with evidence of a significant income shift from the poor to the rich. Secondly, comparing growth elasticities and poverty, the study found increasing poverty incidence, although absolute poverty remained low. The civil war in Rwanda resulted in higher inequality in the country. However, pre-conflict data made it difficult to empirically identify the inequality impact. In addition, McKay and Loveridge (2005) provided evidence of a widening income gap for Rwandans when comparing real income pre-conflict and post-conflict.

In contrast to the two previous papers in this strand, Bircan, Bruck, and Vothknecht (2017) used macro-level panel data fixed effects for 128 countries covering the period 1960-2004. They analysed the impact of violent conflict on economic inequality as measured by the Gini index. They empirically computed the distributional effects of conflict and its persistence over time. They found that, on average, inequality increased over the course of a conflict. They estimated an average increase of 1.7 and 2.7 Gini points during and immediately after a conflict, respectively. This emerges as a result of the negative impacts on tax revenue generation, the demographic deterioration in the labour market through death and displacement, and the disruption of agricultural production activities. The subsequent decline is observable within the first five years after the end of a conflict, suggesting the role of centralised redistribution after a conflict concludes. In particular, the role of state engagement

in social spending, large military budgets, and an increased age dependency ratio are implicated as possible mechanisms for increased inequality post-conflict.

Building on his theory that war or conflict is a leveller of inequality, Scheidel's (2017) empirical evidence suggests inequality levelling post-conflict. Evaluating countries' top income percentiles across different war periods (1932-2010), the author reported a decline in the top income share immediately after a war's end and for several subsequent decades. The wartime changes varied across countries in line with their degree of involvement. However, conflict predicts an overall decline in inequality, with the top 1% the most affected.

An interesting empirical case for the foregoing is provided by Japan in terms of the mechanism through which conflict leads to a reduction in inequality. Scheidel (2017) analysed the direct effect of war on Japan's inequality using the Gini coefficient. Given the available data, Japan saw a dramatic drop in the national Gini after the end of World War II. Income inequality in Japan has been estimated to have been reduced by between 0.45 to 0.65 Gini points (see Moriguchi and Saez, 2008). Data discontinuities impact the full account of the change from 1940-1955. This massive shift in the distribution of income in Japan was associated with the destruction of the wealth of the top 1% of wealth holders (i.e., the Japanese elites). The nature of the military bombing strategy used by the US Air Force saw high deaths and widespread destruction of Japanese industrial wealth owned by the elites (i.e., the Zaibatsu). The defeat came with the subjection of the Japanese to US-imposed institutional and constitutional reforms. This led to a sharp levelling effect that impacted wealth inequality in Japan. Government interventions that created a planned economy, together with high inflation and physical capital destruction, flattened Japan's wealth and income distribution by the end of the war. The decline in inequality was also apparent for other countries like Germany and France.

Scheidel (2017) persuasively documented evidence that the most prevalent and persistent outcome of war for affected economies from the earliest periods of history to contemporary times has been the destruction of the wealth of the elites.

As noted in Essay 1 of this thesis, the empirical evidence on the effect of the Sierra Leone civil war is limited and largely focuses on political engagement, local institutions, and behavioural and enterprise-level outcomes (see Bellows and Miguel, 2006, 2009; Cecchi, Leuveld, and Voors, 2016; Collier and Duponchel, 2013). Sam (2015) analysed the impact of the Sierra Leone Civil war on asset accumulation, and Essay 1 above focuses on the conflict's effect on average household expenditure levels and poverty rates.

The above literature review reveals that the more conventional approach when exploring the relationship between equality and conflict is to focus on the role of inequality – in either its vertical or horizontal form – in providing a trigger for conflict. The empirical evidence reveals limited support for the notion that vertical inequality as measured by income inequality is a catalyst of conflict. In contrast, there does appear more persuasive evidence that horizontal inequality, as measured by group-based disparities in political representation, access to public resources, and labour market opportunities, provides a more potent driver for the start of civil conflict. However, there is a significant gap in the existing literature investigating the direct impact of conflict on household welfare distribution and inequality. The contribution of Scheidel (2017) points to the importance of such a relationship as one of the legacies of a catastrophic conflict. Thus, the motivation for this paper is to use the framework advanced by Scheidel to investigate the relationship between conflict and household welfare inequality in Sierra Leone and, in doing so, to contribute to a very small body of existing literature on this important topic.

3.4 Data

The distributional impact of the Sierra Leone civil war on household welfare and inequality is assessed using three separate cross-sectional datasets, as used in Essay 1. These are the 1989 Sierra Leone Household Survey that pre-dates the war and two post-war Sierra Leone Integrated Household Surveys from 2003 and 2011, respectively. The datasets contain information on household expenditure, which allows us to construct two metrics that inform on household inequality. The first outcome of interest is provided by the log of per capita household expenditure evaluated at different quantiles, while the second is the Gini coefficient based on total (unlogged) household expenditure levels.

The 1989 SLHS dataset provides the baseline against which household inequality, either immediately after the civil war in 2003 or about a decade after the war's end in 2011, is evaluated. Statistics Sierra Leone in conjunction with the World Bank conducted the two SLIHS post-war surveys (in 2003 and 2011). The survey data from 2003 provide a profile of the socio-economic status of households in Sierra Leone immediately after the Lomé peace agreement in 2002. These post-war data provide a basis for empirically estimating the short-term effect of the civil war at different household expenditure quantiles using a household inequality measure (i.e., the Gini coefficient). The latter of the two post-war datasets is exploited to obtain empirical estimates for the longer-term effect of the civil war on the selected outcome variables. It might also provide an understanding of the post-war recovery trends, potentially shedding light on the strategies and programmes implemented to mitigate the impact of conflict on household welfare.

The above surveys utilise the same sampling method, which was based on 2,553 Enumeration Areas (EAs) identified using the 1985 population and housing census. The populations in these

enumeration areas were updated for the 2003 survey using a census conducted by Statistics Sierra Leone in 2000. This was designed to account for any systematic population movements since 1985.

As already documented in the first empirical chapter, a central difference between the sampling approach used in the earliest survey in 1989 compared to that of the two later surveys was the number of chiefdoms sampled. In 1989, the sampling was restricted to a randomly selected set of 64 chiefdoms from a total of 152 chiefdoms in Sierra Leone. In the subsequent surveys, undertaken in 2003 and 2011, the sampling of households was drawn from all 152 chiefdoms. Therefore, as in Essay 1, we explore as part of a robustness check whether the estimates obtained are sensitive to the more restrictive chiefdom sampling used at the baseline in 1989.

The empirical methodology employed relies on the allocation of households to either high conflict intensity or low/no conflict intensity chiefdoms within Sierra Leone. As indicated in the contextualisation section, the war began in the eastern regions of the country and gradually spread to chiefdoms in other areas. There was substantial destruction in those chiefdoms that experienced prolonged occupation by the rebels. These regions suffered from the destruction of private property and other wealth-generating assets due to the tactics employed by the rebel groups. The rebels exercised a strategy based on targeting high-value assets, which comprised looting, occupying, and (in some cases) destroying private property. In contrast to the eastern chiefdoms, the western and some northern chiefdoms experienced limited or even no conflict. These areas were protected by the government's armed forces in collaboration with four other international military groups and largely remained free from rebel force occupation. The penetration of the western and surrounding region occurred near the end of the war. There was

some property destruction in this area during this short, intensive event, but not on the same scale as experienced in other regions subjected to protracted territorial control by the rebels.

In order to classify the households that were exposed to or affected by the civil war, following the approach in Essay 1, two measures of conflict based on binary variables are again used. The first is the conflict exposure variable, which captures conflict incidence by exposure to violence in each administrative chiefdom. As in Essay 1, the conflict intensity information used to construct this dummy variable is obtained from the No Peace Without Justice report (see Smith, Gambette, and Longley, 2004). The binary measure for a household's exposure to the conflict is defined as 1 for those households in chiefdoms that experienced a protracted period of rebel group activity and occupation, a high incidence of conflict-related deaths, and other war-related activities. The dummy is otherwise set to 0. The construction of the dummy variable is restricted to using chiefdom level information, as this represents the highest level of compatible regional disaggregation available across the three datasets used. Appendix 1 in Essay 1 contains a map that highlights the administrative chiefdoms of Sierra Leone and the intensity of conflict to which they were exposed during the war (see Figure A 2.1 in Appendix 1).

The binary conflict variable defined above delineates the treatment and the control groups for our analysis. It is emphasised that the treatment reflects not only the effects of conflict-related violence but also the influence of a protracted occupation by rebel forces. The treatment exposure is interpreted in broader terms than those captured or described by conflict intensity alone. Its definition also provides a more explicit sense of the mechanisms through which the civil war impacted household welfare.

Second, as in Essay 1, we use a second binary treatment measure based on information on households that have directly suffered war-related events (e.g., family or relatives killed, limbs amputated, household members raped, household members displaced, or property destroyed or lost). This measure is taken to capture whether or not any members of the household are war victims. For obvious reasons, this treatment variable is only available for the two post-conflict datasets of 2003 and 2011. This will again be referred to as 'conflict event' as opposed to the first measure, which is defined as 'conflict exposure'.

The three household-level surveys contain both individual-level demographic information and household-level characteristics across the chiefdoms of Sierra Leone. We construct two welfare metrics for each of the three years. First, we construct a measure of per capita household expenditure at different quantiles.[5] Statistics Sierra Leone (SSL) prepared the 1989 dataset and provided the data containing aggregate household expenditures. However, the original source data for the different expenditure items are not now accessible from SSL, so it is not possible to disaggregate this measure into its component parts. In contrast, for the 2003 and 2011 household surveys, the household expenditure data are computed using the different components of household expenditure. The computations used in this study adhere to the definitions originally used by SSL for the 1989 survey. Second, we use the household expenditure data to determine a measure of household inequality using the Gini coefficient. The resultant outcome variable is a continuous index that ranges from 0 to 1. The closer the Gini coefficient to 0, the lower the level of inequality across households based on their expenditure levels. These two measures are used to estimate the impact of the civil war on household welfare distribution.

[5] This per capita expenditure level is calculated by dividing total household expenditure by the number of adults in the household.

As a prelude to the econometric analysis, summary statistics for our first outcome variable (i.e., the log of per capita expenditure) are presented in Tables 3.1, 3.2, and 3.3 below for selected quantiles. The statistics are represented for the three years of investigation (i.e., 1989 SLHS pre-war dataset and the two follow-up datasets, 2003 and 2011 SLIHS). A general overview from Table 3.1 provides the first insight on the distribution of household expenditure pre-war and post-war using percentile ratios for both conflict measures (i.e., conflict exposure and conflict events).

Table 3.1: Sierra Leone Household Expenditure Percentile Ratios by Conflict Status

	Exposure			**Events**		
	$\frac{90^{th} - 10^{th}}{50^{th}}$	$\frac{90^{th} - 50^{th}}{50^{th}}$	$\frac{50^{th} - 10^{th}}{50^{th}}$	$\frac{90^{th} - 10^{th}}{50^{th}}$	$\frac{90^{th} - 50^{th}}{50^{th}}$	$\frac{50^{th} - 10^{th}}{50^{th}}$
1989:						
Overall	10.1315	9.3909	0.7406			
Conflict	8.1130	7.2757	0.8373			
Non-conflict	9.3891	8.6631	0.7260			
Change	-1.2761	-1.3874	0.1113			
2003:						
Overall	2.5614	2.0107	0.5507	2.5614	2.0107	0.5507
Conflict	1.6637	1.1458	0.5178	1.7371	1.2310	0.5061
Non-conflict	3.2174	2.6255	0.5919	2.5779	1.9142	0.6636
Change	-1.5537	-1.4797	-0.0741	-0.8408	-0.6832	-0.1575
2011:						
Overall	1.7594	1.2538	0.5056	1.7594	1.2538	0.5056
Conflict	1.4519	0.9523	0.4995	1.7169	1.2285	0.4884
Non-conflict	1.8489	1.3409	0.5079	1.7918	1.2212	0.5706
Change	-0.3970	-0.3886	-0.0084	-0.0749	0.0073	-0.0822

Note to Table 3.1: '*Change*' denotes the difference between conflict and non-conflict.

The percentile ratios calculated allow the analysis of the expenditure differences when comparing two points within the distribution. We are interested in determining the welfare differences for those at the bottom half and top half of the distribution. The difference between the 50^{th} and the 10^{th} percentile relative to the median in column 4 of Table 3.1 represents the expenditure distribution at the lower end of the distribution. The difference between the 90^{th} and the 50^{th} percentile relative to the median represents the welfare gap at the top end of the distribution. However, an important comparison is based on the difference between the top and

bottom 10 percent of the expenditure distribution. This is reported in columns 2 and 5 in Table 3.1 for conflict exposure and conflict events, respectively. This latter comparison presents the first insight on the relationship between the civil war and household welfare inequality. Prior to the civil war, Sierra Leone exhibited a much higher expenditure gap between the 'richest' and 'poorest' compared to the post-war years. The dispersion of household expenditure in Sierra Leone denoted by the standard deviations (see Table 3.2) also indicates a higher variation in household expenditure prior to the civil war than in its immediate aftermath.

Table 3.2: Standard Deviation of Log of Household Expenditure by Conflict Status

	Exposure			**Events**	
	1989	2003	2011	2003	2011
Standard dev:					
Overall	1.4596	0.7627	0.6121	0.7627	0.6121
Conflict	1.5661	0.6013	0.5602	0.6469	0.5971
Non-conflict	1.3997	0.8608	0.6230	0.8099	0.6553
Change	0.1664	-0.2595	-0.0628	0.1630	-0.0582
F-test	1.2518	2.0493	0.8086	1.2519	1.097
Observations:	**3439**	**3702**	**6685**	**3696**	**6685**
Treatment	**1167**	**1666**	**4041**	**1319**	**5,110**
Control	**2272**	**2036**	**2722**	**2377**	**1653**

Note to Table 3.2: '*Change*' denotes the difference between conflict and non-conflict.

This pre-war phenomenon of a highly unequal expenditure distribution is also evident from the estimated Gini coefficients (see Table 3.3). The overall estimated Gini coefficient stood at 0.672 prior to the conflict. Chiefdoms that ultimately became the conflict-affected zones did not exhibit a different degree of inequality in 1989 compared to what became the non-conflict zones using either percentile ratios or the Gini coefficient. Therefore, the distribution of household per capita expenditure before the civil war was not significantly different between what became the conflict and the non-conflict zones.

Table 3.3: Gini Coefficient for Log of Household Expenditure by Conflict Status

	Exposure			**Events**	
Decomposition	1989	2003	2011	2003	2011
Gini coefficient:					
Overall	0.672	0.442	0.3380	0.442	0.338
	(0.008)	(0.008)	(0.003)	(0.008)	(0.003)
Conflict	0.659	0.377	0.302	0.374	0.335
	(0.009)	(0.012)	(0.005)	(0.013)	(0.004)
Non-conflict	0.677	0.434	0.344	0.437	0.343
	(0.011)	(0.010)	(0.004)	(0.009)	(0.006)
Change	-0.017	-0.057	-0.042	-0.063	0.008
	(0.014)	(0.016)	(0.006)	(0.016)	(0.007)
t-value for difference	-1.219	-3.563	-0.700	-3.938	1.143

Note to Table 3.3: '*Change*' denotes the difference between conflict and non-conflict; bootstrapped standard errors with 250 replications in parenthesis.

Figure 3.1 represent the kernel density of household expenditure approximately two years before the civil war. The general distribution was similar across what became the conflict and non-conflict areas. The conflict zone had higher expenditure levels for most of the distribution. This provides further complementary evidence that the conflict zones were marginally better off in terms of their expenditure profiles before the onset of the civil war, particularly for those households at the top end of the distribution. However, those at the bottom end of the distribution in what became the conflict-affected areas were worse-off pre-war. It is arguable that this level of inequality may have given the conflict greater traction in these areas.

Table 3.4: Difference in Log of Household Expenditure between Conflict and Non-conflict Areas

	1989	***2003***		***2011***	
Mean & Percentiles	**Exposure**	**Exposure**	**Events**	**Exposure**	**Events**
Mean	0.0526	-0.2641***	-0.5345***	-0.2462***	-0.195***
	(0.0621)	(0.0502)	(0.0419)	(0.0407)	(0.0419)
10^{th}	-0.2506***	-0.0996***	-0.2045***	-0.1530	0.0210
	(0.0611)	(0.0485)	(0.0456)	(0.0026)	(0.0382)
25^{th}	-0.1037***	-0.1388***	-0.3553***	-0.1718***	-0.0879***
	(0.0649)	(0.0360)	(0.0434)	(0.1805)	(0.0326)
50^{th}	-0.0000	-0.1613***	-0.4663***	-0.2392***	-0.2296***
	(0.1028)	(0.0324)	(0.0370)	(0.0184)	(0.0340)
75^{th}	0.3696***	-0.3527***	-0.6084***	-0.3385***	-0.3289***
	(0.0777)	(0.0413)	(0.0374)	(0.0240)	(0.0335)
90^{th}	0.1589**	-0.5881***	-0.7859***	-0.4461***	-0.3280***
	(0.0813)	(0.0503)	(0.0403)	(0.0349)	(0.0367)

Significance levels
*** p<0.01, ** p<0.05, * p<0.1

Figure 3.1: Log of Household Expenditure for Conflict Exposure (1989)

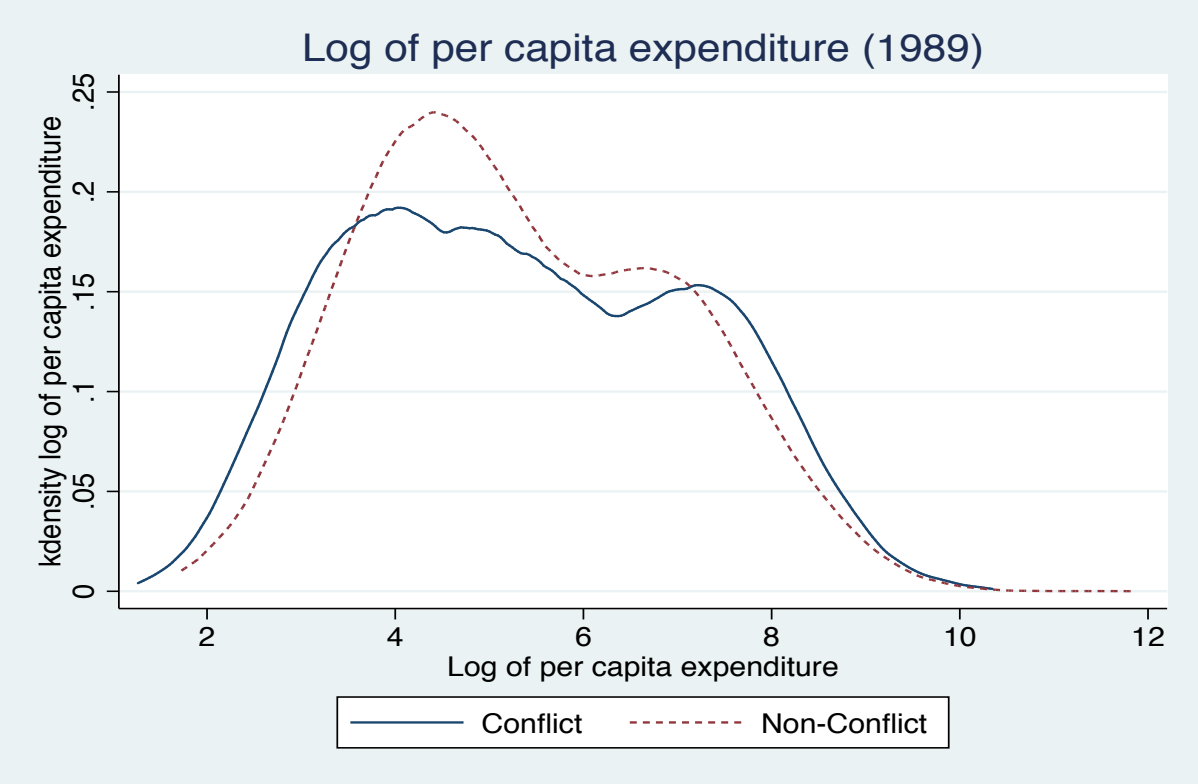


Figure 3.2: Log of Household Expenditure for Conflict Exposure (2003)

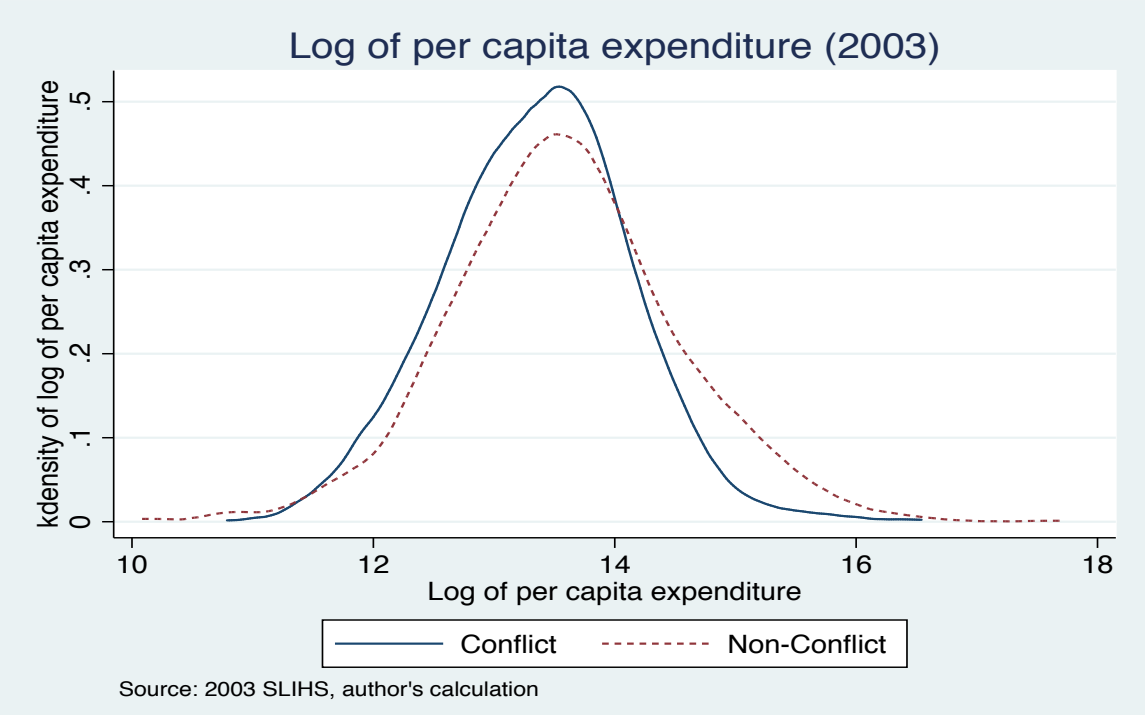
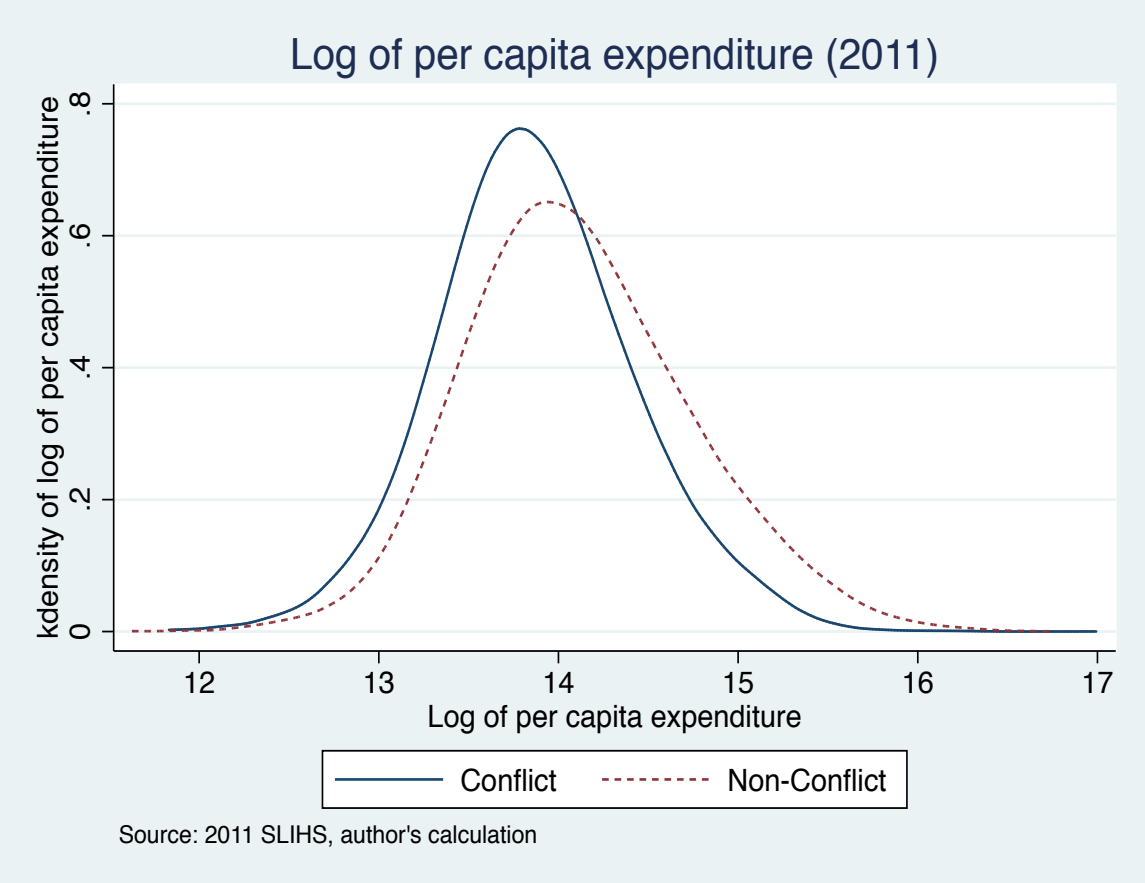


Figure 3.3: Log of Household Expenditure for Conflict Exposure (2011)



The foregoing narrative changes dramatically in the immediate aftermath of the civil war. The household expenditure percentile ratios are lower across the two measures of conflict (exposure and events). The contraction in the percentile ratio is more prominent at the top end of the distribution. The emergence of lower standard deviations in the log of expenditure and a contraction in the Gini coefficients is also evident (see Tables 3.2 and 3.3, respectively). These estimates suggest a sharp reduction in the inequality in household welfare after the conclusion of the civil war. The overall inequality measure (i.e., the Gini coefficient) reduces to 0.442 as compared to the pre-war level of 0.672. Furthermore, over the longer term, the Gini estimates exhibit a further contraction to 0.338 for households in chiefdoms affected by the civil war.

The story is similar for households or household members directly affected by the civil war.

The short-term summary statistics using the percentile ratios, the Gini coefficient, and household expenditure quantiles depict a reduction in household expenditure inequality after the war.

The above statistical summary provides an insight on how the 11 years of conflict in Sierra Leone impacted the distribution of household welfare. A possible explanation can be related to the civil war having a negative effect on those households at the top end of the expenditure distribution with either marginal or no improvement for those at the bottom. These descriptive statistics suggest a negative association between conflict and household inequality, though reveal nothing about the presence or otherwise of a causal effect. In order to empirically estimate the casual impact of the conflict on the distribution of household expenditure, two empirical methodologies are adopted, and these are explained in the next section.

3.5 Empirical Methodology

The objective of this research is to attempt to causally estimate the impact of the Sierra Leone civil war on household welfare distribution. Two main empirical methodologies are used. They are based on the estimation of Recentred Influence Function (RIF) regression models for the Gini index, and the estimation of an unconditional Quantile Treatment Effect (QTE).

3.5.1 Recentred Influence Functions

This methodology is exploited to evaluate the impact of the civil war on household inequality using the Gini coefficient as the inequality measure. This is actually done using a methodology exploiting a concept known as the Recentred Influence Function (RIF). This approach was developed by Firpo, Fortin, and Lemieux (2009) and initially utilises the concept of the influence function. Assuming a distributional statistic is continuously differentiable, the first order directional derivative is known as the influence function (IF). The IF represents the influence of an individual observation (or, more broadly, data contamination) on the distributional statistic of interest. For example, the influence function of the population mean μ (i.e., E(Y)) is the demeaned value of the outcome variable $Y - \mu$. Thus, the IF is centred around 0. If the distributional statistic of interest is added back to the IF, this yields the RIF. This is centred around the statistic of interest (μ) and not 0.

As discussed by Firpo et al. (2009), the RIF can be obtained for any distributional statistic and not just the mean. In particular, it can generally be done for most inequality measures like the variance and the Gini Coefficient. In the current context, the RIF for the Gini coefficient is used and enables us to examine the impact on the distribution of household inequality as measured by the RIF-based form of the Gini coefficient. The RIF can be expressed as a

systematic linear relationship between the selected household and conflict-specific covariates.[6] Essamah-Nssah and Lambert (2011) outlined how the RIF concept can be applied to the Gini coefficient. The RIF for the Gini is given by:

$$\text{RIF} = (\text{y};\text{G}) = 2\frac{\text{y}}{\mu}\text{G} + \frac{1-\text{y}}{\mu} + \frac{2}{\mu}\int_0^{\text{y}} \text{F}(\text{z})\text{dz} \qquad (3.1)$$

while the RIF for the Lorenz ordinates is given by:

$$\text{RIF (y;L(p))} = \begin{cases} \frac{\text{y}-(1-\text{p})\text{qp}}{\text{u}} + \text{L(p)} * \left(1 - \frac{\text{y}}{\mu}\right) & \text{if } \text{y} < \text{qp} \\ \frac{\text{Pqp}}{\text{u}} + \text{L(p)} * \left(1 - \frac{\text{y}}{\mu}\right) & \text{if } \text{y} \geq \text{qp} \end{cases} \qquad (3.2)$$

where y is the household expenditure level. Hence, the RIF-based Gini is expressed as a linear function of household i characteristics (**X**) and conflict as follows:

$$E[\text{RIF}(\text{y}_\text{i};\ \upsilon)|\text{X}, \text{Conflict}] = \mathbf{X_i}'\boldsymbol{\beta} + \alpha\text{Conflict}_\text{i}, \qquad (3.3)$$

where α represents the marginal effect of household conflict exposure or conflict-specific events status (Conflict_i) on the Gini Coefficient (ν). Household- and chiefdom-level characteristics are represented as X_i. Equation 3.3 is our main regression specification for which the estimates are discussed in the empirical result section for the RIF-based Gini.

We regress equation 3.3, the RIF-based Gini coefficient measure on a set of household covariates (X_i) and the conflict variable. In addition to the inclusion of conflict status in the regression model above, we also control for head of household characteristics like age, gender, education, and marital status. Household size, the dependency ratio, and a dummy variable for

[6] See Firpo, Fortin, and Lemieux (2018) for details on the RIF regression approach for the Gini coefficient.

settlement type (urban area) are also included as controls. The RIF regression is estimated by OLS and has a similar set of interpretations as an OLS estimator (see Firpo et al., 2009). The parameter estimates from the RIF regression model represent unconditional marginal effects.

The above estimation approach helps us to determine the impact of conflict on the overall Gini coefficient as per equation (3.3). In order to assess the robustness of the key estimate, the regression model is estimated in three different ways: (i) unweighted; (ii) weighted by propensity scores; (iii) unweighted but with propensity scores included as an additional regressor. In addition, we also compute the average treatment effect on the Gini using a propensity score matching (PSM) technique and an inverse probability weighting (IPW) procedure. Four of these methods require the estimation of a treatment assignment equation. The treatment assignment equation depends on household characteristics that can determine household inequality but are not affected by the conflict. The estimation is done using a binary logit model (see Table A3.1 in the appendix) to predict the propensity scores based on the specified set of characteristics as described earlier in Essay 1. The characteristics used for the matching are reported in Tables A3.2-A3.5 in Appendix 2.

The above estimation methods provide an understanding of how household expenditure inequality is affected by the conflict (through using either the exposure measure or the conflict event measure) as mediated through the Gini coefficient. A disadvantage of the above set of methods, though, is that they do not provide insight on the impact at different points of the welfare distribution as they only provide the impact of conflict on overall inequality. An analysis of the conflict effect at specific points of the household expenditure distribution may thus be informative. This can be achieved through estimating effects of interest at different

quantiles of the household expenditure distribution. This provides insights on the impact of the conflict on selected quantiles and hence inequality, and a suggested approach is now outlined.

3.5.2 Quantile Treatment Effect

The unconditional Quantile Treatment Effect on the Treated (QTT) method is used to provide in finer detail the impact of conflict on the distribution of household expenditure. This approach allows the analysis to go beyond the average effect and reveals the heterogeneous distributional impacts on the outcome of interest, which is not discernible from a Gini coefficient. The empirical methodology and the assumptions underlying the computation of the QTT, as originally proposed by Firpo (2007), are now discussed below.

The Quantile Treatment Effect (QTT) is defined as a marginal difference between two cumulative functions at a particular percentile distribution (see Doksum, 1974; Lehmann, 1974). This estimation of this particular quantile definition is conditional on the rank position of the individual observation in the distribution remaining unchanged regardless of its treatment status. This assumption is referred to as the rank preservation assumption (see Firpo, 2007). The rank preservation assumption can be unreasonable if the policymaker is interested in the marginal distribution of the potential outcomes, which can be computed through quantile treatment estimation. This reinforces the fact that QTT represents the differences in the marginal distributions of the potential treatment and control outcomes between quantiles. The above definition was invoked by Firpo (2007) to estimate the QTT with an additional strong assumption of exogeneity of the treatment conditional on selected covariates.

The following definitions are necessary to an understanding of the empirical methodology of Firpo (2007), which is followed in this study. T is defined as an indicator variable for the treatment (i.e., the conflict measure in this case). Hence, the potential outcome of individual *i*

will be observed as $Y_i(1)$ if T=1. Alternatively, it becomes $Y_i(0)$ if T=0. Respectively, $Y_i(1)$ and $Y_i(0)$ are the potential outcomes of being in the treatment or control groups. The treatment assignment for individual i can be expressed as follows:

$$Y_i = Y_i(1) \cdot T_i + Y_i(0) \cdot (1 - T_i) \quad (3.4)$$

The treatment effect parameters for the QTT are identified under a set of necessary restrictions required for estimation. The relevant restriction imposed in the estimation by Firpo (2007) is the assumption that selection into the treatment is based on observable characteristics. This is simply a restatement of the exogeneity assumption based on the conditional independence assumption, which implies that the assignment of individuals to either the treatment or control group given a set of observables is random. This is also known as the unconfoundedness assumption in the literature (see Rubin, 1977) and was originally encountered when using the propensity matching score (PSM) technique in Essay 1. The assumption is used for the computation of the conditional average treatment effects on the treated (ATT) in the estimation of the unconditional quantile treatment on the treated (QTT) estimates.

A key identification strategy in the estimation of QTT with control variables is the requirement of having both observable and unobservable characteristics that ensure the response variable is independent. This has been done by generating the marginal quantile distribution within a common support framework to identify the cumulative distribution function of the response variables conditional on the covariates. However, in this approach suggested by Firpo (2007), the identification results are directly related to the quantiles of the marginal distribution. This mitigates against the need for the calculation of the cumulative density functions as suggested by Imbens and Newey (2003). Firpo (2007) adopted a semi-parametric method of estimating the quantile treatment effects. This is achieved through a first step non-parametric estimation

of the propensity scores, which are then used as part of the weighting estimator to simulate a random allocation into treatment and control groups.

We now consider the case of the QTT estimation in the context of the Sierra Leone civil war, where we explore the impact of the war at different points of the household expenditure distribution. In order to estimate the quantile treatment effects of the conflict on household expenditure, we first predict household conflict status and follow the estimation technique suggested by Firpo (2007). We create two separate dummies for conflict measures as mentioned in the data section. We denote T=1 if either (i) a household is in a chiefdom that was under protracted rule by rebel groups (conflict exposure) or (ii) a household or a household member was directly affected by the civil war (conflict events). If a household is not in one of these respective categories (i.e., not affected by the conflict for the two measures), then T=0. The two scenarios are considered as two different treatments, with the estimated impact effect computed separately. The quantile treatment effect on the treated (τ) as described by Firpo (2007) can be expressed as follows:

$$\Delta^{\tau} = q_{1,\tau}|_{T=1} - q_{0,\tau}|_{T=1} \qquad (3.5)$$

where $q_{1,\tau}|_{T=1}$is the outcome variable for conflict-affected households at quantile τ, while $q_{0,\tau}|_{T=1}$ is the outcome in the absence of either conflict exposure or a household conflict event. The above is obviously characterised by an inference problem known in this setting as the counterfactual quantile for the treated sample, $q_{0,\tau}|_{T=1}$, which is unobserved. Given that we have observational data and neither a panel nor data from a randomised control trial, the simulation requires the creation of a counterfactual distribution of the household welfare measure. So as to bring this into the context of the unconditional quantile treatment effect of the treated household, the following propositions are evaluated. Household welfare is proxied by log per capita household expenditure (y), a vector of observable characteristics (X), and a

treatment status T. This provides a joint distribution of household expenditure and observable characteristics conditional treatment status as follows:

$$F(y, X|T = t) \tag{3.6}$$

Following Firpo (2007), we assume conflict is exogenous, conditional on household characteristics (i.e., the selection on observables assumption). We further assume that the support of included covariates is independent of the treatment (i.e., conflict status). These assumptions can be denoted as follows:

$$(y_0, y_1) \perp\!\!\!\perp T|X$$

$$0 < \Pr(T = 1|X) < 1$$

The densities of household expenditure at each conflict status are estimated by weighted kernel estimators with the Epanechnikov kernel function and the Silverman (1986) bandwidth.[7] The weighting estimator for each quantile is a traditional (inverse) propensity score-weighting estimator and can be expressed as:

$$(\widehat{\alpha}, \widehat{\Delta^{\tau}}) = \arg min_{\alpha,\Delta} \sum w_i^f \times \rho_\tau (q_i - \alpha - T_i\Delta) \tag{3.7}$$

with:

$$w_i^f = \frac{T_i}{(\Pr (T=1|X_i)} + \frac{1-T_i}{1-\Pr (T=1|X_i)} \tag{3.8}$$

The above weight follows the inverse probability weighting approach using the estimated propensity scores obtained semi-parametrically from a treatment assignment equation. The weight of being in a conflict-affected zone based on observable characteristics, $\Pr(T = 1|X_i)$, is needed for the above weighting procedure.

[7] The Silverman bandwidth is the optimal smoothing parameter that should be generated based on the characteristics or distribution of the data. The optimal bandwidth usually falls with the range of 0.6 to 1.4 for the analysis undertaken here.

The estimated quantile treatment effect of the conflict on the distribution of household welfare is the expected difference between households randomly allocated into conflict and non-conflict states. The estimation itself uses the minimisation approach outlined in Firpo (2007) based on the expected differences using the above weights. The estimated quantile treatment effect on the treated can then be expressed as:

$$QTT^{\tau} = \widehat{\Delta^{\tau}} = \arg min_q \sum_{i=1}^{N} w^{f}_{1|T=1}\, \rho_{\tau}(q_i) - \arg min_q \sum_{i=1}^{N} w^{f}_{0|T=1}\, \rho_{\tau}(q_i) \qquad (3.9)^{8}$$

This above equation is the difference between the unconditional quantiles of the observed treated distribution and the counterfactual (or untreated) distribution. The difference provides the quantile treatment effect for a specific quantile ($\hat{\tau}$). The crucial assumption is the 'selection on observables' in the re-weighting function. The selected observables should be sufficient to control for the fact that difference in household expenditure between the conflict and non-conflict zone is driven by being either exposed to rebel occupation or directly affected by the civil war. Equation (3.9) is our main estimate specification for the quantile treatment effect that will be discussed later in the empirical result section.

We first estimate a model of the probability of a household being in the conflict zone based on the included set of observable variables relative to those in the non-conflict zone. This follows a local logistic model estimation approach embedded in the 'ivqte' command in Stata. The observable characteristics included should be pre-determined and not affected by the conflict but may be determinants of household expenditure. The non-parametrically estimated propensity scores predict the probability of a household being in the conflict zone. We generate three smoothing parameters of 0.83, 0.86, and 0.84 for the three years of estimation,

[8] In this case, $\rho_{\tau}(u) = \{u \times (\tau - 1(u < 0)\}$ a convex linear programming problem and is solved efficiently with the build-up 'ivqte' command in Stata with analytical standard errors that are consistent in the presence of heteroskedascity (Frollich and Melly, 2010). It should be noted that although the STATA routine is known as 'ivqte', we do not require an instrumental variable for identification here as selection is based on exogenous observables and not endogenous unobservables.

respectively, using the 'locreg' command. The selected (observable) controls in the treatment assignment equation help to mitigate the selection bias assuming they are highly correlated with the unobservable characteristics. The relevant variables were discussed in the data section above and include head of household characteristics (e.g., age, gender, education, and marital status), and other household demographics (e.g., household size, settlement area, dependency ratio, tribal and religious status). These controls are assumed to not be influenced by the conflict.

As with propensity score matching, there must be overlap of the propensity score distributions among households in the conflict and non-conflict groups for the re-weighting procedure to be used. In the absence of overlap of the propensity scores, there will be households in the conflict zone for whom there are no equivalent households in the non-conflict group. The presence of non-overlap in observable characteristics among the groups may lead to a bias in the estimation of the quantile treatment effect.[9] However, there is sufficient overlap of the predicted likelihood of treatment between the two groups, irrespective of the observable characteristics included. Finally, the distribution of the covariates between the treatment and control groups used in the estimation of the above quantile treatment effect are not systematically different after re-weighting (see the over-identification tests result with respect to the Inverse Probability Weighting approach in Table A3.9 in the appendix).

[9] The estimated treatment equation used in the QTT analysis provides broadly similar estimates to those of the treatment assignment equation used in the propensity matching technique for the first part of the methodology of the Gini coefficient and for the ATT reported in Essay 1. The estimated propensity scores from the two treatment equations (QTT of expenditure and the Psmatch regression) are highly correlated (0.999) across the different years. The overlap of the covariates is the same as represented in Tables A3.2 to A3.5 in the appendix.

3.6 Empirical Results

3.6.1 Logistic Model and the Propensity Score Estimation

Table A3.1 in the appendix presents the standard logistic model results from the treatment assignment equation. The assignment equation generates the probability of being in the conflict zone (propensity score) for each household. As discussed in the methodology section, the propensity score is used for the two different approaches in estimating the impact of the conflict on household inequality. Firstly, it serves as a regression weight for the Recentred Influence Function (RIF) using the Gini-based regression model. The second approach uses the propensity score as an additional covariate in the estimation. The logistic estimation to obtain the propensity scores was done separately for three treatment assignment equations, each for three separate years. The specifications differ across years given the objective of achieving good balancing of covariates between the conflict and non-conflict zones. Diagnostic checks using plots of the continuous variables before and after the weighting estimation on the propensity score revealed good predictive power and balancing (see Table A3.5). In addition, the local logistic regression model estimates for the treatment assignment equation for the QTT are depicted in Table A3.6.

3.6.2 Conflict and Household Inequality using the RIF Gini Coefficient

Table 3.5 presents the estimated household determinants of the RIF-based Gini coefficient for the five different specifications based on equation (3.3). We first focus on the conflict exposure measure. From the unweighted estimates, there is a statistically significant inverse relationship between a household being in the conflict zone and the Gini coefficient in the immediate aftermath of the civil war. This effect is absent both prior to the civil war and 10 years after the end of the war in all cases. The results of the weighted regression using the propensity scores as weights reinforces the negative effect on household expenditure inequality in the immediate

aftermath of the war (see Table 3.5). On average, *ceteris paribus,* being in the conflict zone reduces the Gini coefficient by eight percentage points (see row 2 of Table 3.5). This contraction in equality dissipates in the long-run. Hence, in the immediate aftermath of the civil war in Sierra Leone, there was a reduction in household inequality as measured using the household expenditure metric, though this contraction was not long-lived.

The results of the regression technique that includes the propensity score as an additional covariate are represented in row 3 of Table 3.5. The results from using this technique do not differ materially from the results obtained using the earlier regression weights approach. In addition, the use of the propensity score matching technique supports the negative impact of the conflict on the Gini coefficient with the magnitude slightly below the other estimates reported. The matching technique suggests a reduction in expenditure inequality by 6 percentage points. The results based on the approach using inverse probability weighting provide further evidence of a contraction in inequality in the immediate aftermath of the war by 8 percentage points.

We now discuss the impact of a conflict-related event on household inequality. The weighted regression results are reported in Table 3.5 (see the last two columns). The estimated effect suggests that, on average, *ceteris paribus,* this measure of conflict reduces the overall Gini coefficient immediately after the conflict by 7.5 percentage points. The other estimation techniques, including the regression with the propensity score as an additional covariate and inverse probability weighting, provide magnitudes closer to the weighted estimation results. The average treatment effect from the matching technique indicates a reduction of 7 percentage points.

The conflict event impacts are consistent across the five different estimation approaches used here. These are of broadly similar magnitude to the estimates derived from the conflict exposure measure. The short-run effect of the conflict events on affected households is a reduction in household expenditure inequality. In the long-run, as with the exposure measure, the conflict events are not seen to have a persistent effect. Generally, both conflict measures are in agreement in suggesting a reduction in the Gini coefficient of between 7 and 8 percentage points. In the longer run, 10 years after the end of the war, neither conflict measure is found to have any sustained impact on household expenditure inequality. Therefore, the empirical evidence provided here suggests the impact of conflict on inequality is more short-term in nature than its effect on the mean, which is greater and longer-term.

Table 3.5: The Impact of Conflict on the Gini Coefficient from different RIF Regression Specifications & Other Methods

	Exposure			**Events**	
Estimation Methods	**1989**	**2003**	**2011**	**2003**	**2011**
(1) Unweighted	0.0039	-0.0908***	-0.0052	-0.0802***	0.0008
	(0.0156)	(0.0126)	(0.0050)	(0.0183)	(0.0069)
(2) Weighted	0.0025	-0.0804***	0.0036	-0.0751***	-0.0056
	(0.0140)	(0.0125)	(0.0048)	(0.0214)	(0.0062)
(3) PS regressor	0.0039	-0.0912***	-0.0031	-0.0800***	-0.0031
	(0.0197)	(0.0152)	(0.0050)	(0.0169)	(0.0050)
(4) Matching (ATT)	0.0108	-0.0552***	0.0049	-0.0691***	0.0048
	(0.0184)	(0.0183)	(0.0081)	(0.0265)	(0.0081)
(5) IPW (ATT)	0.0031	-0.0834***	-0.0001	-0.0736***	-0.0063
	(0.0147)	(0.0125)	(0.0048)	(0.0395)	(0.0065)
Observations:	**3439**	**3702**	**6685**	**3696**	**6685**
Treatment	**1167**	**1666**	**4041**	**1319**	**5110**
Control	**2272**	**2036**	**2722**	**2377**	**1653**

Note to Table 3.5: The different regression results are based on (1) OLS without any weights; (2) OLS with the propensity score as weights; (3) 'PS regressor' indicates the propensity score as an additional covariate; (4) the matching estimator is based on a propensity score matching technique (5) the IPW is based on the inverse probability score weighting technique.
Robust standard errors in parentheses.
Significance levels
*** p<0.01, ** p<0.05, * p<0.1

The foregoing results reveal the impact of the Sierra Leone civil war on household inequality as measured by the Gini coefficient. The conflict, on the basis of the overall Gini effect, suggests a significant levelling effect on inequality in the immediate aftermath of the war. Although the levelling effects are sizeable, they are nowhere near the magnitude reported by Scheidel (2017) for either Japan or Germany in the immediate aftermath of World War Two. This analysis is useful and provides insight into the causal relationship between the civil war and household inequality. However, the Gini coefficient does not provide any insight on where along the household expenditure distribution the inequality changes are concentrated. In order to gain deeper insight regarding this issue, we compute QTT effects for each percentile. This will provide an empirical framework for assessing the provenance of the changes in the distribution of household expenditure induced by the conflict, and as observed in the Gini coefficient. In other words, the QTT analysis will shed light on whether the overall impact on inequality is driven by changes in the distribution at the bottom, median, or top end of the household expenditure distribution.

3.6.3 The Impact of Conflict on the Distribution of Household Expenditure

The point estimates and confidence intervals for the estimated QTT effects for the conflict exposure measure for each quantile are graphically depicted in Figures 3.4, 3.5, and 3.6 for each year of analysis, respectively and are based on equation (3.9). The pre-war estimates of log per capita expenditure across the percentiles for the conflict exposure measure are captured in Figure 3.4. Prior to the civil war, Sierra Leone was characterised by an excessively high degree of dispersion in expenditure between what became the conflict and non-conflict zones. Specifically, from around the 52nd percentile onwards there is a statistically significant widening in pre-war inequality between these zones. However, immediately after the civil war, the expenditures for those households in the conflict zone exhibit a sharp contraction from

about the 23rd percentile onwards (see Figure 3.5). This negative reduction widens and becomes more statistically significant with progress along the unconditional log household expenditure distribution. Households at the top end of the distribution incur the greatest conflict-related penalty. This negative effect exhibits some long-run persistence, though the magnitude is more modest in nature (see Figure 3.6).

Figure 3.4: Point Estimates and Confidence Intervals for Quantile Treatment Effects – Conflict Exposure (1989)

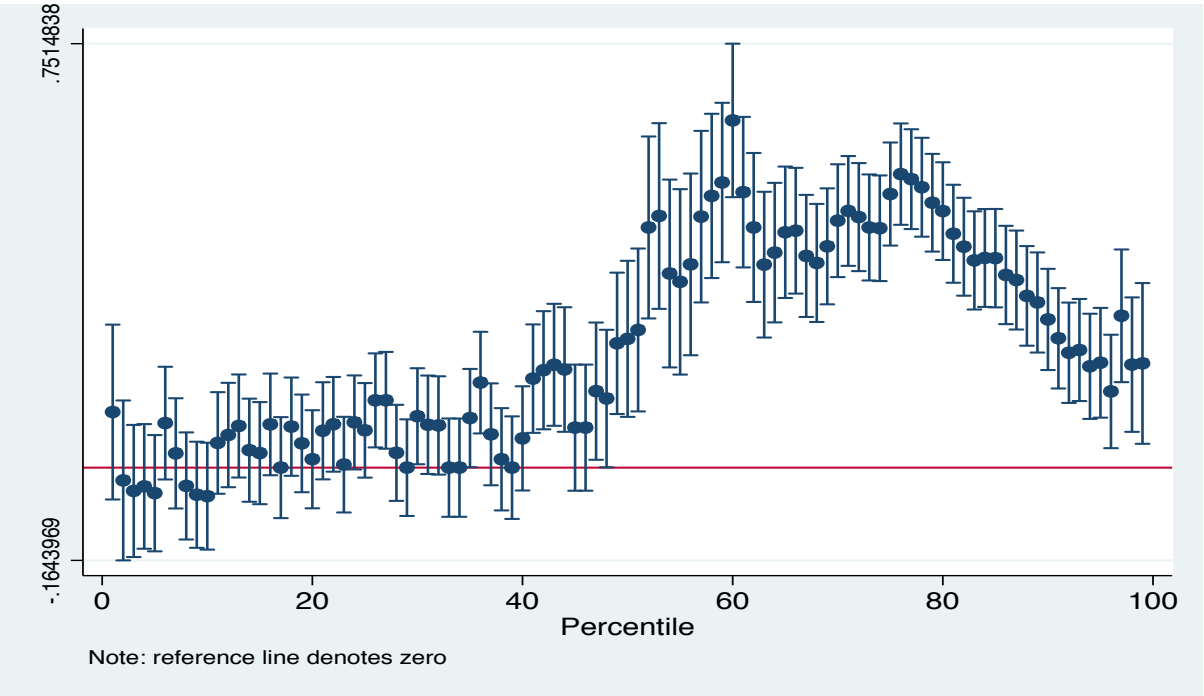


Figure 3.5: Point Estimates and Confidence Intervals for Quantile Treatment Effects – Conflict Exposure (2003)

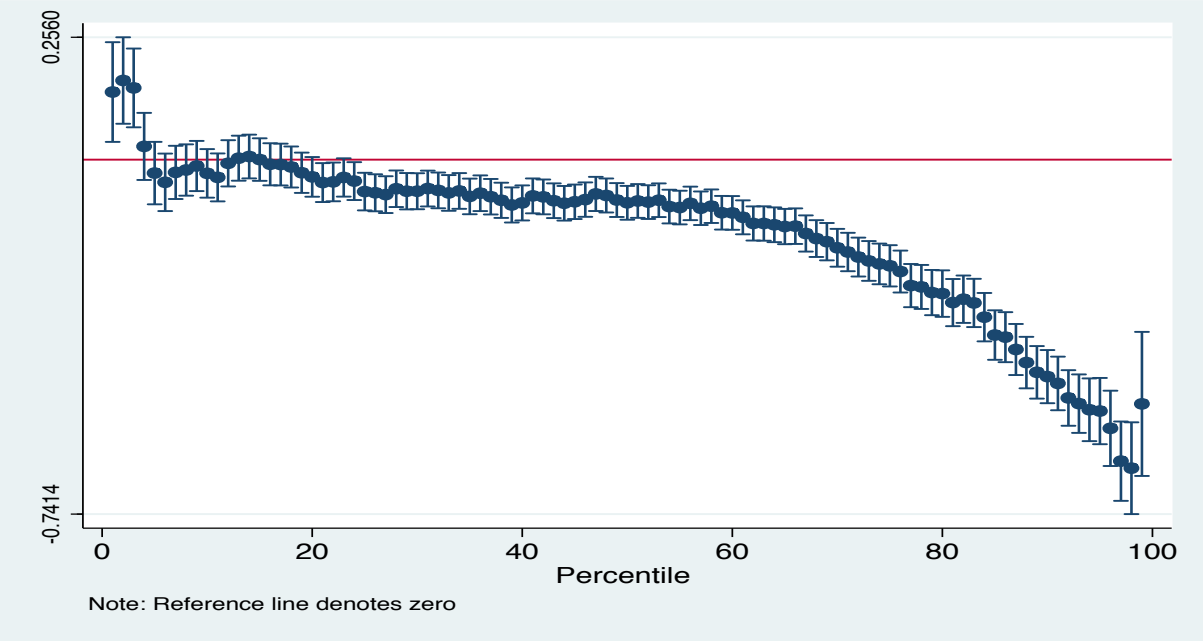
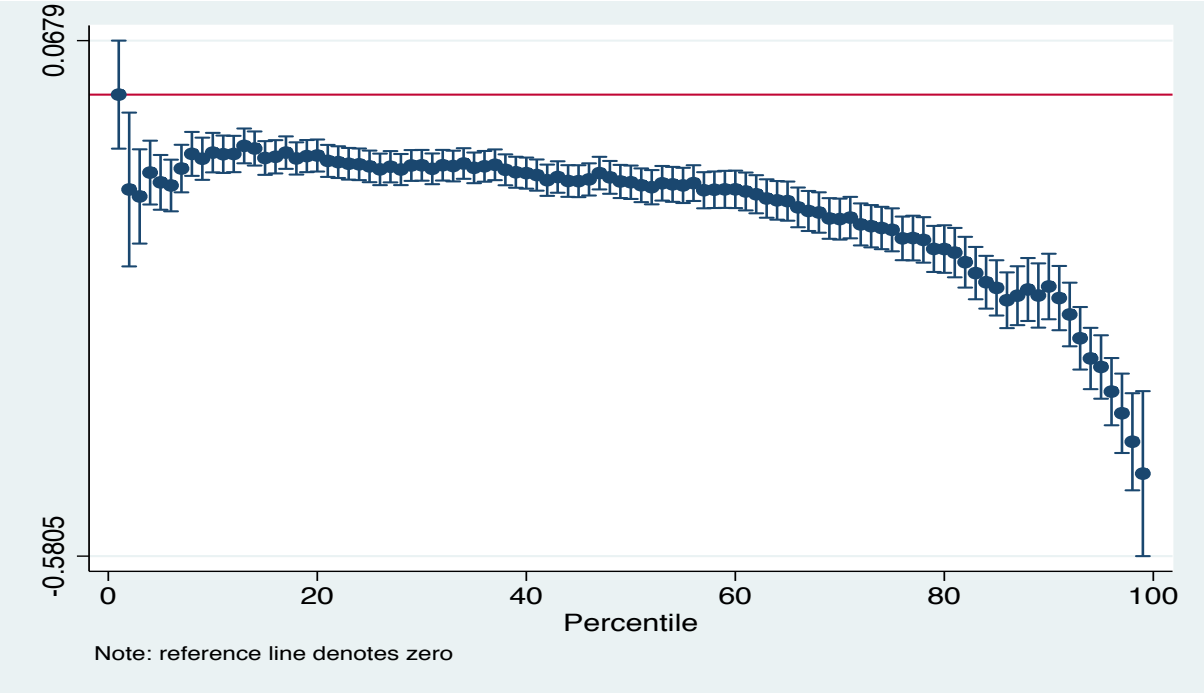


Figure 3.6: Point Estimates and Confidence Intervals for Quantile Treatment Effects – Conflict Exposure (2011)



We provide individual estimates for the conflict exposure measure for selected quantiles of log household expenditure in Table 3.6. Before the start of the civil war, households in chiefdoms that become subjected to high conflict intensity in the form of protracted rebel rule were better off, on average. After the civil war, these chiefdoms experienced a sharp downturn as

household expenditure contracted across most percentiles of the household distribution. The average short-term impact of the conflict was a significant reduction in household expenditure by about 36%. This result comes from the last three columns, which represent the wealthier households in the economy. Households subject to conflict exposure at the 90th percentile exhibited a statistically significant reduction in household expenditure of about 51% compared to those not affected by the conflict. This negative distributional impact remains persistent even in the long run but with a more modest contraction evident in terms of its magnitude. However, there is evidence of some recovery at the bottom end of the household expenditure distribution. Ten years after the official end of the civil war, household at the 10th percentile of the expenditure distribution exposed to the conflict recorded an 8% increase in their household expenditure level. However, households at the 90th percentile continued to endure a sizeable negative penalty. In particular, households located in chiefdoms that experienced protracted rule by rebel groups still had 26% lower household expenditure almost 10 years after the conflict had ended.

Table 3.6: OLS and Quantile Treatment Effects using Log Household Expenditure – Conflict Exposure

	OLS	10th	25th	50th	75th	90th
1989:						
Conflict exposure	-0.0831	-0.0560	-0.1853***	-0.0813	-0.0115	0.1183
	(0.0588)	(0.0825)	(0.0769)	(0.1476)	(0.0876)	(0.1213)
Observations	3,477	3,460	3460	3460	3460	3460
2003:						
Conflict exposure	-0.451***	-0.0968***	-0.2501***	-0.4092***	-0.5853***	-0.7167***
	(0.0473)	(0.0633)	(0.0732)	(0.0493)	(0.0358)	(0.0599)
Observations	3702	3702	3702	3702	3702	3702
2011:						
Conflict exposure	-0.277***	0.0786***	-0.0390***	-0.1401***	-0.2726***	-0.3013***
	(0.0499)	(0.0327)	(0.0183)	(0.0167)	(0.0258)	(0.0369)
Observations	6763	6763	6763	6763	6763	6763

Note: 17 observations were trimmed from the QTT analysis for 1989 with propensity score below 0.0001 and none from the two subsequent years.
The regressions have the following covariates in the treatment assignment equation for the propensity score estimation used in QTE and the OLS regression: age, sex, education, and marital status of heads; household size and it square; household dependency ratio; household in urban area; and some urban and gender interaction variables.
Bootstrapped standard errors in parentheses with 250 replications.
Significance levels
*** p<0.01, ** p<0.05, * p<0.1

Now our attention turns to our second conflict measure, based on conflict events. Table 3.7 presents the estimated impact of the conflict on households that directly suffered from any of the stated events (i.e., household member killed, raped, suffered limb amputation, displaced, and property destroyed or lost). This conflict measure's short-term impact reveals a sharp reduction in household expenditure across the distribution. On average, *ceteris paribus,* households or their members reported to have suffered directly from the conflict saw a 36% reduction as compared to those not affected. In the short-run, households at the 10th percentile experienced a 16.4% reduction in household expenditure. The conflict impact at the 90th percentile was sizeable in the short-run but dissipated sharply in the long run. These observed long-term estimated effects contrast with those obtained using the conflict exposure measure.

Table 3.7: OLS and Quantile Treatment Effects using Log Household Expenditure – Conflict Events

	OLS	**10th**	**25th**	**50th**	**75th**	**90th**
2003:						
Conflict events	-0.446***	-0.1796***	-0.2906***	-0.3885***	-0.5469***	-0.6834***
	(0.0460)	(0.0561)	(0.0582)	(0.0375)	(0.0381)	(0.0576)
Observations	3696	3696	3696	3696	3696	3696
2011:						
Conflict events	-0.0374	0.1788***	0.0602***	0.0473***	-0.0206	0.0358
	(0.0500)	(0.0463)	(0.0278)	(0.0222)	(0.0163)	(0.0255)
Observations	**6763**	**6763**	**6763**	**6763**	**6763**	**6763**

The regressions have the following covariates in the treatment assignment equation for the propensity score estimation used in QTT and the OLS regression: age, sex, education, and marital status of heads; household size and it square; household dependency ratio; household in urban area; and some urban and gender interaction variables.
Bootstrapped standard errors in parentheses with 250 replications.
*** p<0.01, ** p<0.05, * p<0.1

3.7 Robustness Checks

In order to verify our empirical results, we conducted a number of robustness checks similar to what was done for Essay 1. First, Freetown was protected by coalition forces and was a relatively safe environment within which ongoing economic activities occurred. It was the epicentre for both government and non-government institutions engaged in post-conflict recovery activities. Rebel forces briefly penetrated the city near the end of the war, but failed to gain control of the country's capital city. Hence, the economic opportunities in Freetown were different from those in the rest of the country. This has a potential to bias the empirical findings as our control group for conflict exposure includes Freetown. We exclude Freetown from our control group and implement the analysis again. The results are not found to be significantly different from our main analysis (see Tables A3.7 and A3.8 in the appendices). Therefore, the results obtained here are not driven by including Freetown in the control group.

Second, we restricted our analysis to the 64 chiefdoms that were originally randomly surveyed out of a total of 152 administrative chiefdoms in the 1989 SLHS. This provides consistency in regard to the number of chiefdoms used in the analysis. The 2003 and 2011 surveys randomly selected households from almost all of the recorded chiefdoms. Table A3.10 in the appendix supports the negative impact of the conflict across the distribution, though the small sample size leads to less precise estimates. The key findings on the impact of conflict on inequality, however, are no different to those when using only the 64 original chiefdoms (see Table A3.11).

Third, the intensity of the civil war varied across chiefdoms and conflict years. The estimated impact of the conflict might capture spill-over effects due to migration and household displacement. The short-run analysis in particular may be susceptible to estimation bias if

movement between control and treatment zones was significant. However, and as already noted in Essay 1, the migration[10] pattern revealed in survey responses was generally restricted to within treatment or control groups but not between these two groups. The movement of individuals from conflict to non-conflict areas accounts for 3% of those who are reported to have moved in the survey data for 2003. If these cases are dropped from the analysis, the key findings reported above are not materially altered. The result is not significantly different for the impact on household inequality as compared to our main analysis (see Tables A3.12 and A3.13).

Household displacement during the civil war may provide nuance to the interpretation of our long-term empirical estimates. The results could be driven by returnee contributions to socio-economic activity. An estimated two million Sierra Leoneans were displaced during the civil war as reported in the 2004 NPWJ report. This accounted for over one-third of the Sierra Leone population in 2004 (Statistics Sierra Leone, 2004 Population and Housing Census report). Displacement was mostly internal, as neighbouring Liberia was also undergoing civil war and the border to the north was highly guarded by the Guinean military, deterring entry to the country. A self-reported question on whether a household was displaced as a result of the civil war was asked in the 2003 SLHS. Households displaced during the civil war accounted for 7% of the total households surveyed. This percentage is clearly not representative of the general displacement pattern. However, if we drop the relevant 7% from our short-term analysis, the core results are not significantly altered (see Tables A3.12 and A3.13).

[10] The migration related question in the 2003 SLIHS captures movement in the last 12 months. We used migration to Freetown and other regional epicentres for conflict results.

Displacement and the role of returnees might be less problematic for our short-run analysis as the data was collected just one year after the conflict ended. However, the long-term impact might have potential bias if displacement is not adequately captured. In the 2011 SLIHS, which provides the main data for our long-term analysis, 51% of households report displacement as a result of the civil war. Summary analysis of the survey data reveals that by the end of 2003, 93.5% of war-displaced households had returned to their place of origin. Internal displacement (within chiefdom or province) accounted for 98.33% of all displacement. It is unlikely that the economic conditions of those displaced from their original chiefdoms would have changed significantly. Neighbouring Liberia was also experiencing unrest, while language barriers and strict Guinean border controls discouraged meaningful external displacement. Re-estimation without the 6.5% of households that had not returned to their place of origin after the end of the civil war also left our key findings unchanged (see Tables A3.13 and A3.14).

Finally, the course of household inequality after the civil war could also be affected by the flow of aid and other forms of international assistance. The provision of aid is usually geared towards social reconstruction or providing a financial boost to a government for its development policies. The effect can either be an increase or decrease in equality among households (Bircan et al., 2017). Post-conflict Sierra Leone saw an increase in international aid geared towards rebuilding and enhancing the lives of affected individuals. These aid agencies were generally more effective two years after the civil war had ended and had their offices in the capital city as most were unsure about the stability of the country. Our immediate post-conflict data was collected one year after the end of the civil war. Hence our short-term effect is unlikely to have been driven by such aid disbursements as they were yet to be rolled out effectively. Nevertheless, as noted earlier, we excluded Freetown from the control group analysis and our results were not found to be significantly different (see Tables A3.7 and A3.8).

Hence, aid transfer policies are unlikely to account significantly for the inequality reduction noted post-conflict. It is more reasonable to assume that the rebel activities that took place during the civil war (i.e., the destructive redistribution of wealth), had more of an effect than post-conflict activities.

3.8 Discussion of Results

The existing discussion around conflict and inequality has largely focussed on macroeconomic transmission channels. The macroeconomic evidence to date suggests conflict is associated with higher income inequality in conflict-affected countries. However, there is potential heterogeneity here as conflict-related economic inequality can be dynamic and differ from country to country. The empirical results from our analysis of the Sierra Leone civil war reveal a reduction in household expenditure and inequality as measured by the Gini coefficient. Hence, post-conflict Sierra Leone initially presents as a country with worsening household welfare but reduced inequality. This characterisation suggests an economy of increasing poverty but one complemented by a lower degree of inequality. This is not an atypical occurrence for developing countries that have experienced a prolonged period of conflict. The levelling of inequality is generally channelled through the destructive nature of civil war, where little redistribution occurs. As discussed by Scheidel (2017) conflicts that cause depletion of wealth within the top income brackets can lead to a sharp decline in inequality.

The impact of the civil war in Sierra Leone on inequality can be understood through both the military strategies used during the war and the subsequent post-war recovery policies. The following provides a discussion of the potential mechanisms for the observed reduction in inequality and poor household welfare in post-conflict Sierra Leone.

The strategies employed by the rebel groups and other rebellious national soldiers can be used as one of the explanations for the negative welfare effect. The 'operations' conducted by the rebel groups and their accomplices were destructive in nature. These strategies were orchestrated and encouraged by the rebel leaders. The targeted households and their communities lost assets to the rebels. Looting, raiding, and theft from properties were among the strategies used by the rebels, together with the destruction of private dwellings. These strategies were driven by acquisitive motives but also by the desire to drive fear into the populace to ensure community compliance with the occupation. The targeting of high-value assets by the rebels rendered the 'haves' in society vulnerable to the expropriation of their assets and they thus became the biggest losers during the conflict. In addition, the purloined wealth was not redistributed to the poor in the community. The strategy followed a destructive pattern as the looted wealth was not directed to any meaningful or productive economic activity. Hence, those households at the top end of the welfare distribution incurred the greatest loss in the immediate post-conflict era in Sierra Leone with no obvious benefit for others in the country.

A strategy designed around destruction and theft instead of redistribution accounts for the reduced level of inequality witnessed in Sierra Leone in the post-conflict period. This finding supports Scheidel's (2017) somewhat pessimistic view that conflict is a great leveller of inequality. This is evident for a conflict that permeates society in such a way that the wealth of the affluent is targeted and destroyed. The unequal distribution prior to the civil war is lost during the prosecution of the war. Hence, the immediate post-conflict configuration is an economy with reduced welfare and lower inequality. The scale of the destruction during the civil war can directly affect the magnitude of inequality, as Scheidel (2017) found for both Germany and Japan at the end of the Second World War.

Social and public spending post-conflict also plays an important role in moulding post-conflict inequality. The state's ability to implement and engage in social spending is essential to reducing inequality. Prior to the civil war, Sierra Leone was at the bottom of the world development index and enjoyed limited economic opportunities. The destructive nature of the war led to further deepening of poverty and the development of adverse economic conditions. The protracted rule of rebel groups in certain areas potentially caused the collapse in the state's ability to provide social amenities and other public services and goods relevant to development. The suppressive tactics of the rebels account for the deepened inequality experienced by the rebel-controlled chiefdoms. Corruption, lack of security, and a breakdown in markets provide another perspective as to why the conflict had a high levelling impact on inequality. Overall, the empirical results obtained in this essay confirm Scheidel's (2017) discussion on the mechanisms through which war exerts an inequality-levelling effect. The end of the civil war created more stable economic conditions, which over time have enabled the economic system to exert its influence on inequality, which may explain why inequality has subsequently widened again but not to its pre-war levels.

3.9 Conclusions

In this chapter, the impact of the Sierra Leone civil war on household welfare inequality was examined. The findings contribute to a relatively sparse literature on the link between conflict and inequality. This is the first empirical work that has looked into the impact of the Sierra Leone conflict on household inequality. Household inequality was measured by the Gini coefficient. We used two measures of conflict, one that explored the impact at the chiefdom level and another which looked at the specific conflict events that directly affected a household or individuals in a household. This chapter used two main empirical methodologies in a novel way to estimate the impact of the Sierra Leone conflict on the household expenditure distribution. The first empirical approach evaluated conflict impact using a Recentred Influence Function (RIF) for the Gini coefficient. This was done using a variety of different regression approaches (including RIF regressions). A second approach was used to compute the quantile treatment effect at different quantiles of the household expenditure. This approach permitted estimation of the causal effects beyond the average, as in Essay 1.

Our analysis revealed that the conflict induced a significant negative effect on household expenditure inequality in the short run using both empirical approaches. Households at the top end of the expenditure distribution exhibited the greatest reduction in welfare, with their expenditure halving. In addition, the level of inequality as measured by the Gini coefficient contracted by around 8 percentage points due to the conflict. The effect on inequality dissipated after a decade. The empirical evidence of a sharp decline in inequality immediately after the civil war is in line with Scheidel's proposition that conflict is a catalyst in levelling vertical inequality.

Macroeconomic studies have found evidence that conflict increases income inequality. However, the nature of conflict and the experiences of affected countries differ. A protracted civil war can lead to a breakdown in government effectiveness and the deployment of destructive strategies mostly affecting the wealthiest in society. Hence, the immediate impact is likely to be associated with a reduction in overall welfare and declining inequality. The negative impact of the conflict in terms of general welfare and inequality can be mitigated by constructing and implementing policies that are not biased towards one or other end of the welfare distribution. In addition, as the wealthiest have the most to lose in a conflict, it may be that, in the wake of the civil war, wealthy households are less likely to display their assets conspicuously and less inclined to exhibit their wealth in Sierra Leone. This behaviour may act as a constraint on inequality at the top end of the distribution.

Appendix 3

Table A 3.1: Logit Treatment Assignment Equations for Conflict Exposure for Different Years

	Exposure		
Variables	**1989**	**2003**	**2011**
Head's characteristics:			
head's age	0.00789	0.00145	-0.00221
	(0.0199)	(0.00248)	(0.0113)
head's age sq	-0.000157	-	-4.33e-05
	(0.0002)		(0.0001)
head male	0.206	-0.211	0.337***
	(0.126)	(0.153)	(0.0736)
head married	-0.0147	-0.151	-0.294
	(0.163)	(0.166)	(0.261)
head's primary edu	0.535***	-0.0122	0.471***
	(0.0804)	(0.160)	(0.165)
head's higher edu	-	0.0807	-0.493***
		(0.334)	(0.0752)
head Muslim	-	0.352***	-0.724***
		(0.106)	(0.0999)
Other household characteristics:			
dependency ratio	0.0241	-0.0227	0.173**
	(0.0554)	(0.103)	(0.0778)
dependency ratio sq	-	-	0.00934
			(0.0131)
household size	-0.0322	0.207***	-0.152***
	(0.0376)	(0.0505)	(0.0379)
household size sq	0.00615***	-0.0116***	0.00334*
	(0.00219)	(0.00304)	(0.00196)
Urban	-0.118	-1.009***	-3.046***
	(0.149)	(0.262)	(0.196)
Interaction terms:			
head's primary edu × urban	-	0.374	-0.270
		(0.244)	(0.216)
head male × urban	-	0.152	-
		(0.257)	
household size × urban	0.00229	-0.0383	0.195***
	(0.0229)	(0.0268)	(0.0210)
head married × urban	-	0.961***	0.424***
		(0.262)	(0.143)
dependency ratio × household size	-	0.00823	-0.0154
		(0.0156)	(0.0137)
head Muslim × urban	-	-0.0499	0.670***
		(0.167)	(0.136)
head's higher edu × urban	-	-0.871**	-
		(0.432)	
dependency ratio × urban	0.0530	-	-0.234***
	(0.0873)		(0.0523)
head's age × head married	-	-	0.00604
			(0.00462)
household size × head married	-	-	-0.0437
			(0.0279)
constant	-1.294***	-0.859***	2.444***
	(0.486)	(0.260)	(0.348)
Observations	**3439**	**3702**	**6763**

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.2: Pre-war (1989) Covariate Balancing Tests using Conflict Exposure Treatment

	Treated	Control	%bias	t-value	p>t	Variance Ratio
Age of head	42.87	43.01	-1.20	-0.48	0.63	0.98
Age of head sq	1958.50	1971.20	-1.10	-0.45	0.65	1.07
Head male	0.86	0.87	-2.60	-0.98	0.33	0.99
Head cohabiting	0.93	0.93	-0.90	-0.34	0.73	1.02
Dependency ratio	0.90	0.88	1.90	0.84	0.40	1.13
Urban	0.34	0.36	-3.20	-1.17	0.24	1.00
Head prim edu	0.57	0.59	-4.40	-1.55	0.12	0.97
Head higher edu	0.43	0.41	4.50	1.55	0.12	0.97
Household size	5.41	5.44	-0.70	-0.28	0.78	1.01
Household size sq	41.52	41.65	-0.20	-0.09	0.93	1.07
Head prim edu × urban	0.19	0.19	-1.20	-0.44	0.66	0.98
Head male × urban	0.29	0.31	-2.90	-1.06	0.29	0.99

Note: *if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2]
** if 'bad', i.e. variance ratio <0.5 or >2
prim edu – primary education; higher edu – higher education

Table A 3.3: Post-war (2003) Covariate Balancing Tests using Conflict Exposure Treatment

	Treated	Control	%bias	t-value	p>t	Variance Ratio
Age of head	46.80	46.66	1.00	0.29	0.77	0.99
Age of head sq	2386.00	2374.70	0.80	0.22	0.82	0.99
Head male	0.82	0.83	-4.90	-1.47	0.14	0.87
Head married	0.84	0.86	-5.10	-1.58	0.11	1.11
Dependency ratio	0.95	0.94	1.50	0.44	0.66	1.10
Urban	0.30	0.30	-0.80	-0.24	0.81	0.99
Head prim edu	0.09	0.09	0.30	0.09	0.93	1.01
Head higher edu	0.02	0.02	0.20	0.06	0.95	1.01
Household size	6.28	6.25	1.30	0.40	0.69	1.01
Head prim edu × urban	0.04	0.04	0.70	0.22	0.83	1.04
Head male × urban	0.25	0.25	-0.60	-0.17	0.86	0.98
Dependency ratio × urban	0.30	0.30	-0.20	-0.08	0.94	1.08
Household size sq	46.28	45.75	1.20	0.38	0.71	1.01
Household size × urban	1.87	1.90	-0.80	-0.24	0.81	0.99
Head married × urban	0.25	0.26	-1.60	-0.46	0.65	0.98
Head Muslim	0.80	0.80	-0.10	-0.02	0.99	1.00
Head from Temne tribe	0.24	0.24	0.30	0.07	0.94	1.00

Note: * if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2]
** if 'bad', i.e. variance ratio <0.5 or >2
prim edu – primary education; higher edu – higher education

Table A 3.4: Post-war (2011) Covariate Balancing Tests using Conflict Exposure Treatment

	Treated	Control	%bias	t-value	p>t	Variance Ratio
Age of head	45.70	46.05	-2.40	-0.87	0.38	1.05
Head primary edu	0.07	0.06	0.90	0.36	0.72	1.05
Head higher edu	0.05	0.04	1.60	0.70	0.48	1.09
Head male	0.73	0.74	-2.20	-0.78	0.44	1.03
Head married	0.81	0.82	-2.40	-0.92	0.36	1.03
Dependency ratio	1.08	1.09	-0.80	-0.30	0.77	1.01
Household size	5.65	5.66	-0.40	-0.17	0.86	1.11
Age of head sq	2304.40	2320.10	-1.10	-0.38	0.70	1.06
Urban	0.17	0.17	-0.20	-0.09	0.93	0.99
Dependency ratio × urban	0.19	0.19	-0.40	-0.19	0.85	1.04
Head married × urban	0.12	0.12	-0.30	-0.12	0.91	0.99
Head male × urban	0.11	0.12	-0.80	-0.36	0.72	0.97
Head prim edu × urban	0.02	0.02	-0.10	-0.06	0.96	0.99
Household size × urban	0.96	0.94	0.50	0.22	0.82	1.01
Household size sq	37.98	37.45	1.30	0.54	0.59	1.11
Head Muslim	0.78	0.78	-1.10	-0.40	0.69	1.02
Head Muslin × urban	0.12	0.12	0.00	0.01	0.99	1.00

Note: * if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2]
** if 'bad', i.e. variance ratio <0.5 or >2
prim edu – primary education; higher edu – higher education

Table A 3.5: The Rubin's Overall Balancing Property Diagnostics Results across the Three Years for Matched Observations

	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%concern	%bad
1989:									
Exposure	0.00	11.20	0.43	2.10	1.60	9.10	1.24	0.00	0.00
2003:									
Exposure	0.003	19.84	0.283	2.40	2.10	13.00	1.46	0.00	0.00
Events	0.00	17.76	0.54	1.30	1.00	12.20	1.06	0.00	0.00
2011:									
Exposure	0.00	10.79	0.867	1.20	0.80	7.40	1.15	0.00	0.00
Events	0.00	18.84	0.40	1.30	1.40	8.60	1.04	0.00	0.00

*if B>25%, R outside [0.5; 2]

Table A 3.6: Semi-parametric Local Logistic Regression Model for the Treatment Assignment Equation - Quantile Treatment Effect Estimation

		Exposure		Events	
VARIABLES	1989	2003	2011	2003	2011
Head's age	0.0008615	0.00661**	-0.00221	0.00938***	0.0184
	(0.022450)	(0.00290)	(0.0113)	(0.00359)	(0.0123)
Head's age sq	-0.000124***	-	-4.33e-05	-	-0.000153
	(3.93e-05)		(0.000105)		(0.000117)
Head male	-0.171	0.626***	0.337***	0.0511	-0.291***
	(0.146)	(0.186)	(0.0736)	(0.0942)	(0.0818)
Married head	0.0970	-0.657***	-0.294	0.400**	0.344
	(0.182)	(0.210)	(0.261)	(0.204)	(0.256)
Dependency ratio	-0.122**	0.186	0.173**	0.145*	0.0571
	(0.0599)	(0.122)	(0.0778)	(0.0796)	(0.0777)
Urban settlement	0.0205	-1.974***	-3.046***	-0.950***	-1.222***
	(0.177)	(0.282)	(0.196)	(0.162)	(0.191)
Primary	-0.670***	0.957***	0.471***	0.555***	0.370**
	(0.0944)	(0.235)	(0.165)	(0.127)	(0.183)
Higher	-	0.790*	-0.493***	0.305	-0.0749
		(0.433)	(0.0752)	(0.236)	(0.0796)
Household size	-0.0723*	-0.149***	-0.152***	-0.0666**	0.0963**
	(0.0403)	(0.0570)	(0.0379)	(0.0323)	(0.0383)
Primary × urban	-	-0.867***	-0.270	-0.511***	0.158
		(0.306)	(0.216)	(0.172)	(0.240)
Male × urban	-	-1.496***		-0.140	
		(0.287)		(0.116)	
Household size sq	0.00192	0.00312	0.00334*	0.000829	-0.00449**
	(0.00225)	(0.00330)	(0.00196)	(0.00191)	(0.00193)
Household size × urban	-0.0245	0.161***	0.195***	0.0965***	0.0577***
	(0.0250)	(0.0291)	(0.0210)	(0.0169)	(0.0224)
Married × urban	-	1.843***	0.424***		-0.186
		(0.297)	(0.143)		(0.144)
Muslim	-	0.545***	-0.724***	0.191***	-0.0905
		(0.126)	(0.0999)	(0.0720)	(0.105)
Temne tribe	-	-1.886***		-1.017***	
		(0.0915)		(0.0531)	
Muslim × urban	-	0.222	0.670***	0.250**	0.366***
		(0.179)	(0.136)	(0.106)	(0.139)
Higher × urban	-	-1.727***		-0.799***	
		(0.500)		(0.279)	
Dependency × urban	0.0843		-0.234***		-0.219***
	(0.0945)		(0.0523)		(0.0588)
Dependency sq	-		0.00934	-0.00320	-0.00784
			(0.0131)	(0.0141)	(0.0151)
Constant	2.523***	1.651***	2.444***	0.431*	0.476
	(0.227)	(0.310)	(0.348)	(0.234)	(0.349)
Observations	**3439**	**3702**	**6763**	**3702**	**6763**

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.7: Quantile Treatment Effects on the Treated using Log Household Expenditure – Conflict Exposure (without Freetown)

	OLS	10th	25th	50th	75th	90th
1989:						
Conflict exposure	0.2066***	-0.0506	0.0661	0.2283	0.4849***	0.2627***
	(0.0482)	(0.0745)	(0.0817)	(0.1561)	(0.0631)	(0.0710)
Observations	3439	3439	3439	3439	3439	3439
2003:						
Conflict exposure	-0.1292***	-0.0081	-0.0309	-0.0572**	-0.1626***	-0.3522***
	(0.0519)	(0.0448)	(0.0283)	(0.0291)	(0.0373)	(0.0499)
Observations	3582	3582	3582	3582	3582	3582
2011:						
Conflict exposure	-0.1284***	-0.0974***	-0.0934***	-0.1065***	-0.1563***	-0.2119***
	(0.0392)	(0.0312)	(0.0166)	(0.0173)	(0.0226)	(0.0324)
Observations	6683	6641	6644	6644	6644	6685

The regressions have the following covariates: age, sex, education, and marital status of heads; household size and it square; household dependency ratio; household in urban area; and some urban and gender interaction variables.
Bootstrapped standard errors in parentheses with 250 replications.
Significance levels
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.8: The Impact of Conflict on the Gini Coefficient using the Inverse Probability Weighting (without Freetown)

	Exposure			**Events**	
	1989	2003	2011	2003	2011
ATT	0.0031	-0.0780***	-0.0003	-0.0736***	-0.0079
	(0.0147)	(0.0127)	(0.0048)	(0.0395)	(0.0065)
Observations:	3439	3582	6,578	3,696	6,685
Treatment	1167	1666	4041	1319	5110
Control	2272	1916	2537	2377	1653

Robust standard errors in parentheses.
Significance levels
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.9: Overidentification Test from the IPW Estimation

	Exposure		**Events**	
	Chi(2)	P-value	Chi(2)	P-value
1989	18.9270	0.1254	-	-
2003	29.9779	0.1190	19.3462	0.4348
2011	18.5821	0.3530	30.4737	0.1695

Note: the null hypothesis is that covariates are balanced.

Table A 3.10: Quantile Treatment Effects using Log Household Expenditure – Conflict Exposure (64 chiefdoms)

	OLS	10th	25th	50th	75th	90th
1989:						
Conflict exposure	0.2066***	-0.0506	0.0661	0.2283	0.4849***	0.2627***
	(0.0482)	(0.0745)	(0.0817)	(0.1561)	(0.0631)	(0.0710)
Observations	3439	3439	3439	3439	3439	3439
2003:						
Conflict exposure	-0.3918***	-0.1013	-0.2222***	-0.2961**	-0.4577***	-0.6048***
	(0.0606)	(0.0675)	(0.0465)	(0.0404)	(0.0491)	(0.0532)
Observations	2156	2156	2156	2156	2156	2156
2011:						
Conflict exposure	-0.1625***	-0.0831**	-0.0976***	-0.1405***	-0.2576***	-0.3235***
	(0.0582)	(0.0367)	(0.0290)	(0.0253)	(0.0324)	(0.0452)
Observations	3778	3778	3778	3778	3778	3778

The regressions have the following covariates: age, sex, education, and marital status of heads; household size and it square; household dependency ratio; household in urban area; and some urban and gender interaction variables. Bootstrapped standard errors in parentheses with 250 replications.

Significance levels

*** p<0.01, ** p<0.05, * p<0.1

Table A 3.11: The Impact of Conflict on the Gini Coefficient using Inverse Probability Weighting (64 Chiefdoms)

	Exposure			Events	
	1989	2003	2011	2003	2011
ATT	0.0031	-0.0950***	-0.0016	-0.0736***	-0.0079
	(0.0147)	(0.0193)	(0.0068)	(0.0395)	(0.0065)
Observations:	3439	2156	3736	3696	6685
Treatment	1167	894	2233	1319	5110
Control	2272	1262	1503	2377	1653

Robust standard errors in parentheses.

Significance levels

*** p<0.01, ** p<0.05, * p<0.1

Table A 3.12: Quantile Treatment Effects using Log Household Expenditure – Conflict Exposure (Other Issues)

	OLS	10th	25th	50th	75th	90th
2003_Migration issue:						
Conflict exposure	-0.1468***	-0.0149	-0.0542	-0.0928***	-0.2208***	-0.4167***
	(0.0485)	(0.0500)	(0.0358)	(0.0318)	(0.0384)	(0.0512)
Observations	3584	3584	3584	3584	3584	3584
2011_Displacement issue:						
Conflict exposure	-0.1237***	-0.0976**	-0.0968***	-0.1123***	-0.1552***	-0.2115***
	(0.0411)	(0.0294)	(0.0172)	(0.0192)	(0.0236)	(0.0326)
Observations	6540	6540	6540	6540	6540	6540

The regressions have the following covariates: age, sex, education, and marital status of heads; household size and it square; household dependency ratio; household in urban area; and some urban and gender interaction variables. Bootstrapped standard errors in parentheses with 250 replications.

Significance levels

*** p<0.01, ** p<0.05, * p<0.1

Table A 3.13: The Impact of Conflict on the Gini Coefficient using Inverse Probability Weighting (Other Issues)

	2003_migration	*2011_Displacement*
ATT	-0.0967***	-0.0130**
	(0.0132)	(0.0049)
Observations:	3584	6464
Treatment	1580	4063
Control	2004	2477

Robust standard errors in parentheses.
Significance levels
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.14: Log Household Expenditure RIF Regression using propensity score matching – Conflict Events

	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}
2003:					
ATT	-0.1805***	-0.2885***	-0.4072***	-0.4419***	-0.6171***
	(0.0866)	(0.0776)	(0.0592)	(0.0692)	(0.0873)
Observations	3696	3696	3696	3696	3696
2011:					
ATT	0.1634***	0.0613	0.0288	-0.0395	-0.0332
	(0.0500)	(0.0316)	(0.0358)	(0.0446)	(0.0588)
Observations	6763	6763	6763	6763	6763

The regressions have the following covariates: age, sex, education, and marital status of heads; household size and it square; household dependency ratio; household in urban area; and some urban and gender interaction variables.
Bootstrapped standard errors in parentheses with 250 replications.
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.15: OLS Estimates for the Household Determinants of the Gini Coefficient (Unweighted) - Full Estimate Table

Variables	1989	2003	2011
Conflict	0.00398	-0.0908***	-0.00519
	(0.0156)	(0.0126)	(0.00501)
Head's Characteristics:			
head's age	0.00801	0.000236	0.00139
	(0.00518)	(0.000498)	(0.00105)
head male	-0.0329	0.0506*	0.000888
	(0.0221)	(0.0294)	(0.00768)
head married	0.0276	-0.0430	-0.0394
	(0.0274)	(0.0369)	(0.0352)
head's higher edu		-0.0413	0.0152*
		(0.0290)	(0.00903)
head's primary edu	-0.0765***	0.103*	0.0352***
	(0.0231)	(0.0609)	(0.0120)
head Muslim		-0.00776	0.00608
		(0.0190)	(0.00647)
head from Temne tribe	-	-0.0140	
		(0.0179)	
head's age sq	-6.97e-05		-1.51e-05
	(4.85e-05)		(9.42e-06)
Other Characteristics:			
dependency ratio	0.0156**	0.0163	-0.0617***
	(0.00732)	(0.0240)	(0.0120)
dependency ratio sq	-	-	-0.00532**
			(0.00257)
Urban	-0.0602	0.0494	-0.266***
	(0.0740)	(0.0589)	(0.0231)
household size	-0.0119	-0.00251	-0.0705***
	(0.0124)	(0.0116)	(0.00575)
household size sq	0.00103	0.000316	0.00251***
	(0.000712)	(0.000798)	(0.000422)
Interactions:			
head's primary edu × urban	-	-0.107	-0.0243
		(0.0731)	(0.0222)
head male × urban	-	0.0184	
		(0.0541)	
household size × urban	-0.0149**	0.0116	0.0436***
	(0.00700)	(0.00977)	(0.00373)
head married × urban	-	-0.101	-0.00931
		(0.0639)	(0.0156)
dependency ratio × size	-	-0.00202	0.0131***
		(0.00411)	(0.00294)
head Muslim × urban	-	-0.0431	-0.0107
		(0.0363)	(0.0160)
head's higher edu × urban	-	0.191	-
		(0.116)	
dependency ratio × urban	-0.0578***		0.0276***
	(0.0201)		(0.00697)
head's age × head married	-	-	0.000295
			(0.000440)
household size × head married	-	-	0.000630
			(0.00589)
constant	0.594***	0.454***	0.623***
	(0.108)	(0.0590)	(0.0353)
observations	3439	3702	6685
R-squared	0.040	0.027	0.107

Significance levels
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.16: OLS Estimates for the Household Determinants of the Gini Coefficient (Weighted) - Full Estimate Table

		Exposure	
Variables	1989	2003	2011
Conflict	0.00253	-0.0804***	0.00356
	(0.0140)	(0.0125)	(0.00481)
Head's characteristics:			
head's age	0.00802*	5.08e-05	0.000874
	(0.00429)	(0.000398)	(0.000934)
head's age sq	-7.08e-05*		-7.69e-06
	(4.04e-05)		(8.35e-06)
head male	-0.0323	0.0422*	-0.000389
	(0.0201)	(0.0237)	(0.00682)
head married	0.0168	-0.0332	-0.0472*
	(0.0282)	(0.0288)	(0.0262)
head's primary edu	-0.0734***	0.103*	0.0328***
	(0.0204)	(0.0619)	(0.0119)
head's higher edu		-0.0400	-0.000165
		(0.0284)	(0.00765)
head Muslim	-	-0.00668	0.00447
head from Temne tribe	-	-0.0121	
		(0.0172)	
		(0.0181)	(0.00640)
Other Household characteristics:			
household size	-0.00946	-0.00142	-0.0684***
	(0.00925)	(0.0103)	(0.00454)
household size sq	0.000772	0.000248	0.00237***
	(0.000480)	(0.000667)	(0.000321)
dependency ratio sq	-	-	-0.00276*
			(0.00163)
dependency ratio	0.0131**	0.0144	-0.0430***
	(0.00657)	(0.0183)	(0.00807)
urban	-0.101*	0.0536	-0.238***
	(0.0567)	(0.0513)	(0.0223)
Interactions:			
head primary edu × urban	-	-0.103	-0.0337
		(0.0734)	(0.0228)
head male × urban	-	0.0400	-
		(0.0453)	
household size × urban	-0.0178**	0.00717	0.0408***
	(0.00785)	(0.00729)	(0.00377)
head married × urban	-	-0.0959*	-0.00628
		(0.0546)	(0.0155)
dependency ratio × size	-	-0.00120	0.00820***
		(0.00290)	(0.00190)
head Muslim × urban	-	-0.0391	-0.0234
		(0.0348)	(0.0174)
head's higher edu × urban	-	0.163*	-
		(0.0891)	
dependency ratio × urban	-0.0461***		0.0278***
	(0.0165)		(0.00698)
head's age × head married	-	-	-0.000121
			(0.000401)
household size × head married	-	-	0.00617
			(0.00395)
constant	0.603***	0.448***	0.623***
	(0.0926)	(0.0522)	(0.0301)
observations	3439	3702	6685
R-squared	0.048	0.021	0.117

Significance levels
*** p<0.01, ** p<0.05, * p<0.1

Table A 3.17: OLS Estimates for the Household Determinants of the Gini Coefficient for Conflict Events - Full Estimate Table

	Unweighted		Weighted	
	2003	**2011**	**2003**	**2011**
conflict	-0.0802***	0.000775	-0.0751***	-0.00556
	(0.0183)	(0.00693)	(0.0214)	(0.00617)
head's age	0.000821	0.00126	0.00129	0.000812
	(0.00180)	(0.00108)	(0.00166)	(0.00100)
head male	0.0951***	0.000986	0.0908***	0.00174
	(0.0287)	(0.00775)	(0.0300)	(0.00684)
head married	-0.0539	-0.0399	-0.0111	-0.0277
	(0.0857)	(0.0331)	(0.0810)	(0.0353)
dependency ratio	0.000344	-0.0632***	-0.0119	-0.0543***
	(0.0225)	(0.0150)	(0.0271)	(0.0114)
urban	0.0280	-0.282***	-0.00116	-0.264***
	(0.0560)	(0.0198)	(0.0565)	(0.0192)
head's primary edu	0.117*	0.0246**	0.106*	0.0247**
	(0.0620)	(0.0108)	(0.0596)	(0.0101)
head's higher edu	-0.0355	0.0168*	-0.0349	0.00509
	(0.0288)	(0.00882)	(0.0304)	(0.00794)
household size	-0.00791	-0.0751***	-0.0138	-0.0730***
	(0.0116)	(0.00773)	(0.0126)	(0.00724)
head's primary edu × urban	-0.126*	-	-0.0990	-
	(0.0739)		(0.0723)	
head male × urban	-0.0736	-	-0.0838	-
	(0.0577)		(0.0667)	
household size sq	0.000710	0.00244***	0.00104	0.00250***
	(0.000830)	(0.000426)	(0.00101)	(0.000451)
household size × urban	0.0136	0.0435***	0.0167	0.0406***
	(0.00921)	(0.00369)	(0.0118)	(0.00359)
head Muslim	-0.00865	-	-0.0133	-
	(0.0196)		(0.0212)	
head from Temne tribe	-0.0450**	-	-0.0449**	-
	(0.0188)		(0.0213)	
dependency ratio × size	-0.00641	0.0129***	-0.00596	0.0109***
	(0.00507)	(0.00283)	(0.00626)	(0.00253)
head Muslim × urban	-0.0371	-	-0.0232	-
	(0.0358)		(0.0392)	
head's higher edu × urban	0.186	-	0.238*	-
	(0.114)		(0.140)	
head's age × head married	-0.000691	0.000170	-0.00135	-5.07e-05
	(0.00190)	(0.000473)	(0.00182)	(0.000432)
dependency ratio sq	0.00901*	-0.00531**	0.0119**	-0.00477**
	(0.00525)	(0.00268)	(0.00553)	(0.00210)
head's age sq	-	-1.96e-05*	-	-1.31e-05
		(1.01e-05)		(9.59e-06)
dependency ratio × urban	-	0.0280***	-	0.0261***
		(0.00695)		(0.00684)
head's age × size	-	0.000114	-	0.000101
		(0.000123)		(0.000126)
head married × household size	-	0.000996	-	0.000307
		(0.00583)		(0.00621)
head's age × dependency ratio	-	4.67e-05	-	9.65e-05
		(0.000257)		(0.000178)
constant	0.484***	0.644***	0.483***	0.646***
	(0.0974)	(0.0377)	(0.0869)	(0.0335)
observations	3696	6685	3696	6685
R-squared	0.024	0.107	0.022	0.124

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

4 Chapter Four -The Impact of the Ebola Virus on Household Welfare and Inequality in Sierra Leone (Essay 3)

4.1 Introduction

The world has experienced significant waves of both epidemics and pandemics over recent centuries. Plagues and other virus or disease types have induced exogenous shocks on affected regions and countries that have adverse consequences. The impacts of epidemics and pandemics are generally accompanied by economic, social, and political shocks that exacerbate mortality rates and undermine economic activity. Virus outbreaks are among the highest tier of epidemics that have adversely affected economies in the past. Africa has suffered many deadly health shock episodes in more recent times. The 2014-2016 West Africa Ebola epidemic represents one in a sequence of different viral episodes that have ravaged the continent in addition to malaria, yellow fever, cholera, and Human Immunodeficiency Virus (HIV). There have been over 20 smaller outbreaks of the zoonotic Ebola virus in different strains since its first occurrence in the Democratic Republic of Congo in 1976. The 2014-2016 West Africa outbreak started in Guinea and was found to be related to the human consumption of an infected bat. Bats are known to host many viruses but have developed excellent immune systems rendering them less vulnerable to these diseases. Their ability to fly long distances and their social roosting behaviour in areas close to human settlements render them an effective vector for the transmission of diseases across species. The death rate recorded within three months of the Guinea outbreak was significant because inadequate control measures were not put in place sufficiently early. The World Health Organisation (WHO) declared this outbreak an epidemic on March 23rd 2014.

Epidemics can destroy lives and disrupt economic and community activity. Developing economies can be further impoverished when afflicted with epidemic shocks. Epidemics exert

pressure on the health, education, and political systems, which are already characteristically weak in developing countries, thus amplifying their socio-economic impact on affected economies. The evaluation of the impact of epidemics on macroeconomic growth has accounted for most of the literature that has sought to investigate the economic impacts of disease in developing countries. In contrast, the microeconomic research on the topic remains limited. The effects of epidemics on economic growth can be long-term or short-term. For instance, the HIV epidemic produced a long-term impact on economic growth. The affected African economies witnessed a reduction in economic growth (GDP) of between 0.15% and 4% per annum over the period from 1990 to 2015. Poor labour productivity, weak labour supply, and increased spending on medical treatments accounted for much of the negative impact on economic growth (see Dixon, McDonald, and Robert, 2002). However, given the failure to develop a cure for HIV, the medical response was more focused on treatment, and the HIV pandemic yielded a U-shaped recovery pattern. The nature of the economic recovery after an epidemic or pandemic can be slow and more often than not follows a U-shaped pattern. Nevertheless, some epidemics yield a V-shaped economic growth pattern, suggesting a faster economic rebound or recovery. The latter suggests a scenario of short-run disruption to growth but with recovery occurring within a more rapid time period. Given that HIV has been an ever-present disease in Africa since the late 1980s, its economic effects have been more persistent compared to other, more short-term epidemics like Ebola. Hence, one would anticipate that the former yields a U-shaped economic recovery, with the latter more likely generating a V-shaped recovery pattern.

As noted above, the bulk of the literature on the impact of epidemics or pandemics on affected countries has been at the macro-level with an emphasis on economic growth (Dixon, 2002; Haacker, 2008; Weil, 2013). The impact of epidemics on household welfare has not been

extensively researched, especially for those occurring in Africa. The existing dearth of research on the effects of epidemics at the micro-level on household welfare provides the research justification for this essay. The research on this topic has been limited for a number of reasons. First, data limitations pre-outbreak and post-outbreak constrain efforts to provide a systematic quantitative analysis of epidemics at the micro-level. This chapter makes use of a rich dataset on household economic indicators (e.g., household expenditure) and related measures of household welfare conducted at a national level after the Ebola outbreak in Sierra Leone.

Second, even when micro-level data are available, the literature has relied more heavily on descriptive analysis. Most of the micro-level analyses are of the HIV/AIDS epidemic, focus on household livelihoods and socio-economic status, and are largely descriptive in nature (see Chapoto and Jayne, 2008; Nabyonga-Orem, Bezayo, Okema, Karamagi, and Walker, 2008). This essay takes the micro-level research a step further by using both household survey and scientific/medical data on confirmed and suspected cases of Ebola at the chiefdom level. The variation in cases across chiefdoms provides an empirical basis for the separation of households between treated and control groups in order to evaluate the socio-economic impact of the disease. These rich scientific/medical data provide insights on the different patterns of the Ebola outbreak within and across chiefdoms.

Third, the literature on the impact of the West African Ebola outbreak on households is limited, with only descriptive analysis generally available. The literature provides discussion of country susceptibility to the Ebola virus, with most research emphasising the impact on poverty and the increased food insecurity that emerges with the spread of the disease (Fallah, Skip, Gertler, Yasmin, and Galvani, 2015; Troncoso, 2015; Thomas, Nkumzimana, Hoyos, and Kayitakire, 2014). The Ebola outbreak represented another adverse socio-economic shock for West Africa,

and Sierra Leone in particular. Prior to the Ebola outbreak, Sierra Leone was in the process of recovering from a civil war that had ravaged the country for 10 years (1992-2002). Economic growth was gradually improving, with a steady reduction in poverty in the five years immediately prior to the Ebola outbreak (World Bank, 2015). Hence, its effect on household welfare is potentially significant and worth exploring, as the country struggled to develop. Therefore, this chapter adds to a small body of literature on the micro-level evidence for the epidemic's impact on an African economy.

Health shocks' impacts on economic and social indicators and their effects can be exacerbated or controlled through curtailment policies imposed by governments. The global policy response to the recent and ongoing Covid-19 pandemic is actually comparable to that used in Sierra Leone to tackle the Ebola virus. A heavily enforced restrictive response was used to contain the spread of the disease, with adverse social and economic consequences. Hence, this research provides insights on the effects of strict curtailment measures on socio-economic indicators that may have broader contemporary relevance beyond Sierra Leone.

In summary, the objective of this chapter's research is to evaluate the impact of the Ebola outbreak in Sierra Leone on household poverty (measured both objectively and subjectively), food insecurity, and household expenditure and its distribution. The approach uses two measures of Ebola (confirmed cases and quarantined chiefdoms) to explore the consequences of the disease on selected household welfare indicators and the policy responses to it. The motivation for this is to evaluate whether any impacts observed were directly driven by the prevalence of Ebola cases within a chiefdom or more indirectly through the quarantine policies imposed by the government.

The empirical methodology employs a variety of different techniques to interrogate the key research questions outlined above. These include using probit regression models to evaluate the effect of Ebola on both overall poverty and food poverty in terms of the objective data available as well as using subjective responses from households. In addition, the analysis also uses Ordinary Least Squares (OLS) to examine the impact of the disease on mean household expenditure. Furthermore, the research uses the propensity score matching technique in an attempt to causally identify the average treatment effect of Ebola on the selected array of household welfare indicators. The impact of the virus on the distribution of household expenditure is also explored using the Recentred Influence Function (RIF), which is employed both to develop a regression-based Gini household empirical methodology and to estimate selected unconditional quantile regression models at selected quantiles of the household expenditure distribution.

It is hoped that the empirical analysis conducted in this chapter provides an understanding of Ebola's impact on household welfare. The empirical analysis reveals that the two measures used to capture the effect of the Ebola disease both exert negative impacts on household expenditure. The effect was found to be largest and most significant for those households at the top end of the expenditure distribution. In addition, both objective and subjective household poverty increased significantly as a result of the disease for those households in either Ebola-affected or quarantined (i.e., locked-down) areas. Specifically, the number of households below the food poverty line increased sharply in chiefdoms with confirmed Ebola cases and in quarantined chiefdoms. The findings comport with the micro-level evidence on epidemics' impacts on household welfare (Chapoto and Jayne, 2008; Nabyonga-Orem et al., 2008). The disease was also found to have a negative effect on a subjective welfare comparison of household living standards compared with those of neighbours. However, there was no

significant impact of Ebola on household subjective food insecurity. Finally, as with the effect of conflict in the last chapter, inequality, as measured by the Gini coefficient, was found to reduce in the immediate aftermath of the Ebola outbreak. This finding is found to be in close accordance with Walter Scheidel's historical findings on conflicts, epidemics, and pandemics as levellers of economic inequality (Scheidel, 2017).

The remainder of this essay is structured as follows: the next two sections outline the contextual framework of the Ebola outbreak and the relevant literature detailing the economic impact of diseases. Two subsequent sections focus on the econometric methodology and the empirical results. The final section provides some conclusions and policy implications associated with the empirical findings.

4.2 The Sierra Leone Ebola Outbreak and Economic Background

The Ebola Virus Disease (EVD) was first discovered in the Democratic Republic of the Congo (DRC) in 1976. There have been over 20 significant outbreaks of the virus in other parts of Africa since. However, the outbreak in West Africa between 2013-2016 was the worst in the short history of the virus. Its severity and traits were different from those experienced in the past. The outbreak was termed an epidemic by the WHO on the 23 March 2014, and ultimately claimed about 11,316 lives. The West Africa outbreak was associated with animal-to-human (i.e., zoonotic) transmission in the district of Gueckedou in Guinea. This district borders Sierra Leone to the east. The spread mostly affected Guinea, Sierra Leone, and Liberia. Nigeria and a small number of other African countries also experienced sporadic outbreaks of the disease for relatively short periods. The United States of America was also exposed to the virus during a later period in 2015 with the return of international medics originally assigned to West Africa during the epidemic.

The virus inhabits animal species and is believed to be originally found in bats (as with many viruses). Transmission occurs through contact with contaminated fluids from animals, humans, or inanimate objects. The symptoms include high fever, severe muscle pain, diarrhoea, and vomiting. Additional symptoms include external and internal haemorrhaging, mostly through the eyes and mouth. The virus has a potential incubation period of 21 days and once symptomatic, death can occur within one to two weeks. The case fatality rate ranges from 25% to 90% conditional on the stage of the virus, the age and health status of the patient, and the treatment received. This renders it more lethal than Covid-19, for instance. The West Africa Ebola outbreak presented a more dynamic form of the virus. The period between virus onset and symptom manifestation was on average 8-12 days, with related deaths 4-5 days after symptoms appeared (Kerkhove et al., 2015), again considerably more rapid than Covid-19. The virus can only be scientifically detected after symptoms appear and the infectiousness is high at the later stages of the virus. In particular, it is known to be highly contagious in dead bodies. Recovery from the virus gives immunity against it, but potential health issues like loss of sight, joint pain, and other ailments can persist over time. Social stigma and the inability to embark on certain livelihood tasks can impair post-Ebola virus recovery for an individual within West African culture. During the outbreak there was no vaccine, and the lack of understanding of the evolution of the virus provided an additional challenge to preventing its spread. Hence, governments were left with no option than to resort to strong anti-contagion measures like military quarantine, isolation of patients, contact tracing techniques, protective behavioural patterns, and controlled burials (see Fast et al., 2015; Richards et al., 2015). Some of these conventional approaches have also been seen in the curtailment of the Covid-19 pandemic that emerged globally in early 2020.

Sierra Leone was one of the countries hit hardest by Ebola in the region due to its close ties to Liberia and Guinea, were the virus originated. The virus was first detected and confirmed in Sierra Leone on the 25 May 2014. This first case was associated with a traditional healer who cared for a victim from Guinea in Sokoma village in the eastern Province. The spread of the disease swept through the eastern part of the country bordering Guinea, which was the epicentre of the virus. Contagion occurred mostly in the provincial areas but finally reached the outskirts of the capital city in July 2014. Community denial and a traditional belief system centred around close care for the dead led to rampant infection in provincial areas. The rate of infection escalated within the densely populated capital, warranting an emergency response from the government. The country's health system was exposed as weak and unable to manage or cope with the spread of the virus. In response to the virus, the Sierra Leone government and local authorities introduced strategies restricting movement, banning public gatherings, instituting curfews, and forbidding Sunday markets. However, virus transmission was not curtailed, and the government resorted to a set of much stronger restrictive measures. A military quarantine was enacted on 6 August 2014 in districts that were severely affected by the virus outbreak. This was also complemented by military checkpoints to control movement across borders. The whole of Kailahun and Kenema administrative districts were the first areas in the east that were subject to quarantine as they recorded the most Ebola cases. The lockdown was initially imposed for a 21-day period and then extended indefinitely when cases were found not to be abating. This quarantine measure was extended further to Moyamba in the east and Bombali and Port Loko in the north. The quarantine measures lasted no less than 21 days and stretched over 3 to 4 months in some districts, especially in the east. The northern part of Sierra Leone was the last to be exposed to the virus. Tonkolili district in the north was the final district subjected to military quarantine but recovered quickly as local leaders ensured adherence to the lockdown rules even during the zero-case phase. The quarantine policy was imposed on

about one-third of the population. The government of Sierra Leone enforced a national three-day lockdown from 19 to 21 September 2014 to help with contact tracing and rapid door-to-door sensitisation. A team of 28,500 community workers and volunteers promoted infection control and encouraged households to send victims to testing centres. In early October 2014, the United Nations Mission for Emergency Ebola Response (UNMEER) strategised a campaign to isolate all reported cases of EVD through active case finding and contact tracing. They also promoted safe and dignified burial for those whose deaths were Ebola-related.

The government in conjunction with international organisations facilitated the construction of health testing and treatment centres. Diagnostic laboratories were built, and community engagement and social mobilisation were promoted to help track transmission and supress the infection rate. There was no vaccine or therapeutic medication for treating Ebola and this non-availability characterised the outbreak. A vaccine was not actually developed until late 2016, when it was successfully trialled in Guinea. The first vaccine for Ebola was eventually approved in 2019 by the United States Food and Drug Administration (FDA). The Ebola virus gradually levelled out in Sierra Leone a year and a half after its first occurrence there. The country survived the outbreak through suppression of its spread by movement restriction and the use of isolation centres. As discussed by Richards (2014) the transformation or evolution of traditional activities by Sierra Leonians through education mitigated the virus spread and eventually helped end the West Africa Ebola epidemic. For example, limited social interactions and cultural belief sensitisation on safe burial and the washing of dead bodies helped control the virus. Thus, community social responsibility and cohesion provided the pathway to overcoming the disease. On 7 November 2015, the WHO declared no new transmissions in Sierra Leone. The virus had been defeated, but Sierra Leone confirmed the number of EVD cases to be 8,704, with 3,589 confirmed deaths at the conclusion of the epidemic.

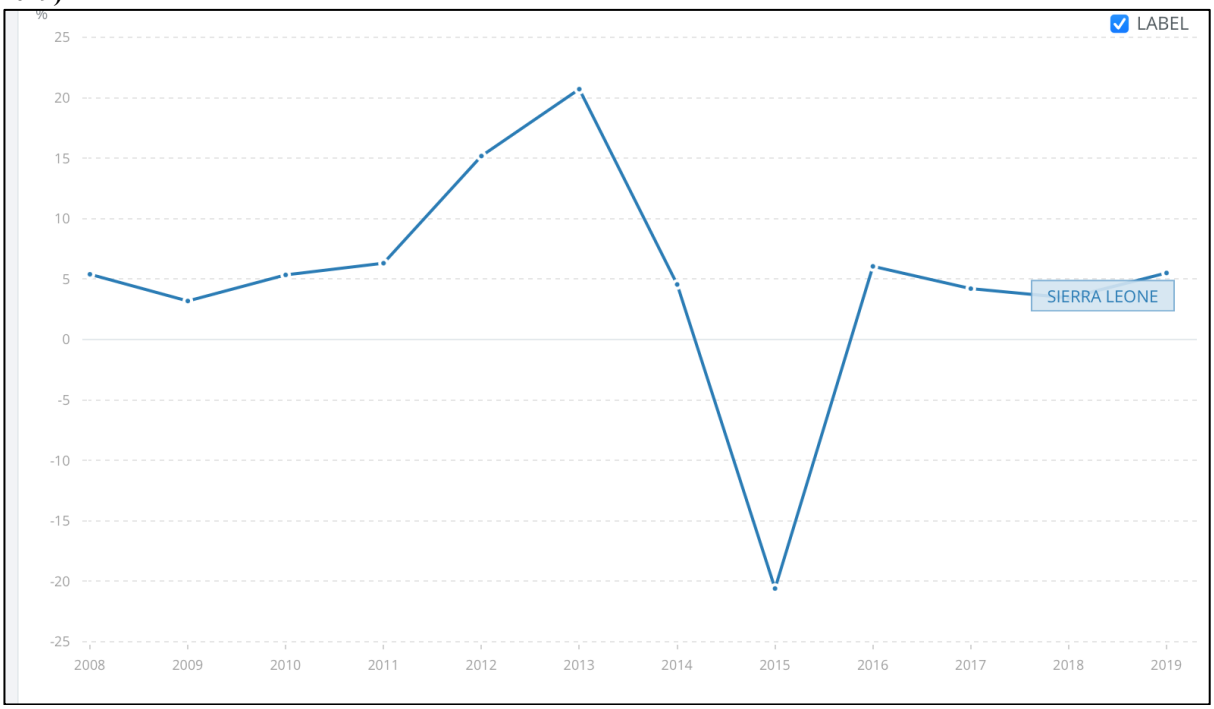
EVD exhibited variation in its spread across Sierra Leone. The transmission dynamic was researched and documented by Fang et al. (2016). They used a weighted-average linkage clustering method to divide chiefdoms into six different patterns (see Figure A4.1 for a heat map of Ebola by chiefdom). The first three patterns included chiefdoms that experienced sporadic outbreaks of the epidemic, chiefdoms that experienced several cases that lasted for 2-3 weeks, and chiefdoms with cases of small-scale outbreaks over a shorter period. The other three patterns included chiefdoms recording multiple or continuous outbreaks over short, medium, and longer periods, respectively. The within-chiefdom transmission rate was high compared to importation from neighbouring chiefdoms. Transmission mainly occurred through person-to-person contact.

The Ebola epidemic in Sierra Leone led to substantial changes in community behaviour. The national and local authorities enforced safe burial and isolation of affected cases. This hindered the popular 'washing of dead bodies' as a last sign of respect among the majority of ethnic groups in Sierra Leone. Densely populated chiefdoms saw higher-intensity Ebola outbreaks. High-cropland chiefdoms exhibited high transmission rates and large numbers of confirmed cases, which affected agricultural activities (Richards, 2016; Coltart et al., 2017). This mainly applied to eastern and southern chiefdoms involved in cash crop planting. The non-gathering of large crowds disrupted the periodic markets, known as 'Lumas', regularly held in most chiefdoms. The food security of these chiefdoms became an important policy issue as most households in the rural areas of Sierra Leone were involved in subsistence farming. The few that operated on a commercial basis depended on daily sales for meeting their food needs. The Ebola outbreak had both short-term and long-term impacts on household poverty and food insecurity outcomes. Hence, an understanding of these effects is essential for shaping policies

to mitigate the negative economic shocks that can accompany such epidemics in the future, particularly at the household level.

Before the Ebola outbreak, Sierra Leone was on the verge of recovering from the negative economic impacts of the country's armed conflict. The country was on a trajectory to attain middle-income development status by 2035 (World Bank, 2019). From 2009, GDP was steadily increasing and then exhibited a sharp decline after the Ebola outbreak in 2014. Figure 4.1 below depicts the annual percentage growth rate of Sierra Leone's GDP between 2012 and 2019. Prior to the Ebola outbreak, the annual percentage increase in GDP was 20.7 percent in 2013. The GDP growth rate started declining after the Ebola outbreak in 2014. The growth rate stood at 4.6 percent in 2014 and the economy was in recession in 2015 with a negative growth rate of 20.5 percent. The economy experienced a recovery in 2016 with an annual growth rate of 6 percent, slowing down to 3.8 percent and 3.5 percent in 2017 and 2018, respectively. The decline persisted for two years, with a slower pace of recovery compared to the pre-Ebola trend (World Bank GDP data, 2018; Statistics Sierra Leone, 2020).

Figure 4.1: Sierra Leone Gross Domestic Product (GDP) Annual Growth Rate in Percentages (2008-2019)



Source: World Bank national accounts data, and OECD National Accounts data files.

The GDP trend after the epidemic depicts a V-shaped recovery from the negative growth rate but not a return to the pre-Ebola trend. The plot anticipates sluggish economic recovery with relatively low growth rates to 2019. It should be noted that in addition to EVD, in 2015, the economy also experienced an additional economic shock through the sharp decline in iron ore prices leading to the closure of a number of mining companies.[11] Nevertheless, the economic output lost during the Ebola outbreak is estimated to have amounted to about $75 million, with significant disruption to the agricultural sector. Over 50% of private sector employment was directly affected by either EVD or the curtailment policies, and the manufacturing sector incurred a 60% loss in employment (see Government of Sierra Leone, National Road to Ebola Recovery report, 2015). Overall, although other minor economic shocks also characterised this

[11] The two largest mining companies, Africa Minerals and London Mining, closed their operations in March and October in 2015, respectively. The mining industry accounted for 30% of Sierra Leone's GDP in 2012. Hence a deep fall in iron prices, the major contributor, caused a negative shock in the economy. Tonkolili district was the home of these two giant mining companies. The downward spiral of world prices of iron and the Ebola crisis presented a perfect storm for the mining industry (see https://www.metalbulletin.com for a detailed synopsis of the iron mining crisis in Sierra Leone). Marampa and Biriwa chiefdoms in the northern districts contained mining sites. These are included in the Ebola-affected chiefdoms in Table A4.1 in the appendix.

period, the impact of EVD was to reduce economic activity and macroeconomic growth and plunge Sierra Leone into another economic crisis. The magnitude of the effects of the contraction due to EVD are subject to debate but are likely to be sizeable compared to, for example, the impact of the closure of iron ore mines. It is intended that the research in this chapter will provide some empirical insights on the potential magnitude of these effects.

It is not subject to debate that the country's socio-economic indicators exhibited a sharp contraction after the first phase of the Ebola outbreak in Sierra Leone. According to the report from the 2015 Ebola High Frequency Cell Phone Survey, conducted by Statistics Sierra Leone in collaboration with the World Bank, employment, food security, and education were significantly affected.[12] Statistics Sierra Leone conducted three rounds of the survey, in November 2014, January-February 2015, and May 2015. The responses suggested that a reduction in agricultural activities and business closures due to curtailment procedures were largely responsible for the downturn. By the end of the second phase after the lockdown, there was evidence of recovery in the agricultural sector and greater access to social services (e.g., health facilities). However, the employment rate was low as most businesses were still struggling to run effectively given the restrictions on their commercial activity. The survey also highlighted coping strategies used by households as the primary mitigating factors off-setting the negative impact of the Ebola virus on food security. The coping strategies became less significant as the government became more effective in mobilising food transfers and other support for affected households and regions. Urban employment and improvements in agricultural harvests reduced the adverse impacts on food security (Statistics Sierra Leone,

[12] The Ebola High Frequency Cell Phone Survey was conducted for a sample of households drawn from the 2014 Labour Force Survey. The survey was conducted on the phone with heads of households on the socio-economic indicators during the Ebola crisis in three different rounds. In total, 1,780 households responded to at least one of the surveys (see Ebola High Frequency Cell Phone Survey, report, Statistics Sierra Leone, 2016; data link: http://ddghhsn01/index.php/microdata.worldbank.org)

2015). Although it is acknowledged that the closure of mines exerted some effect on economic activity over this period, the overall adverse effects appear to be related to the Ebola virus and the policy responses introduced to mitigate its effects.

4.3 Literature Review

The aim of this research is to explore the impact of the 2014 EVD outbreak in Sierra Leone on the country's poverty status and an array of other welfare indicators. Development monitoring and policy interventions have focused heavily on the reduction of poverty, as measured by household income or consumption. These policies were central to the structural adjustment programmes initiated in the 1980s and in the attempts to achieve the Millennium Development Goals in more recent decades. As noted in the first essay, poverty measures are based on household monetary metrics, which are usually benchmarked against a pre-determined monetary value defined as the poverty line. This is derived from household expenditure or income and yields an absolute poverty line that demarcates the poor as those below the poverty line (Ravallion, 2012). This measure was used in the previous two essays of this thesis and is used again here.

Understanding poverty and how to alleviate it is a key policy concern for any country facing a public health shock. Therefore, it is important to use a variety of different metrics of household welfare to investigate the impact of the disease. To this end, researchers distinguish between the concept of subjective and objective poverty, where the latter is determined directly by a household's income or expenditure as above. However, an understanding of both is relevant for cross-referencing and for understanding the dynamic pathways of poverty. This research will borrow from both strands to assess the impact of Ebola in Sierra Leone on poverty in terms of both objective and subjective measures and using both food and living standards.

The impact of Ebola on poverty has been investigated mostly using descriptive statistics rather than econometric analysis. The former type of analysis has placed the disease among the group of Neglected Tropical Diseases (NTDs). Troncoso (2015) describes the outcome of NTDs on poor countries as a further potential channel into poverty and greater inequality. This effect is ossified through the already poor health facilities and the low availability and usage of pharmaceutical treatment interventions. In addition, the development of vaccines for such diseases in poorer countries is limited given their prohibitive research costs.

The socio-economic status of a community or a country was a major factor in the transmission of Ebola in West Africa. An investigation into the transmission and spread of the epidemic showed higher intensity for those regions, counties, or communities that were disadvantaged and characterised by higher levels of poverty. Fallah et al. (2015) categorised 300 communities in Montserrado County, Liberia according to their socio-economic status (SES) to evaluate their susceptibility to Ebola. The authors used data on 4,437 Ebola cases in a time-dependent stochastic model framework. The base data were used to evaluate contact tracing in detecting new cases. The authors found that low-SES communities reported three more contacts on average per person, which is double the number compared to the average-SES communities. The effect increased to 3.5 times when compared to those in high-SES communities. This provides an indication of the greater vulnerability to Ebola transmission of those locations with already-high levels of poverty and privation. In other words, as with Covid-19, poorer socio-economic groups also appear more vulnerable to EVD.

In the context of Sierra Leone, M'bayo (2018) discussed an array of historical indicators establishing a link between the epidemic, poverty, and socio-economic inequality. Extracting qualitative evidence from the extant literature on related epidemics experienced in Sierra Leone

since the colonial period, news, and reports of health parastatals, the author proposed a number of mechanisms through which the Ebola outbreak sheds light on the underdevelopment of the country. The author suggested political mismanagement, nepotism, inequality of access to public amenities, and lack of public trust as the main drivers that reinforced the spread of EVD in Sierra Leone.

The impact of disease or virus outbreak on household food security is also relevant to policy formulation and implementation. A descriptive analysis of the West Africa Ebola epidemic on food security suggests an adverse effect for households directly impacted by the virus (i.e., through death or surviving Ebola-infected victims) and impacted through direct government quarantine policies. Reducing household income through restrictions on movement and trade can directly affect food security, as accessibility is often limited. The informal sector and agricultural households are likely to experience a disproportionate change in their incomes. Border closures suppress the income inflow for households dealing in cash crop production (see Thomas et al., 2014).

Epidemic outbreaks generate significant economic shocks that can lead to substantial changes in the development process. Diseases have repercussions for economic growth in African countries. The HIV and AIDS diseases identified in the early 1980s resulted in an estimated 32 million deaths world-wide as of 2018, rendering it a pandemic that ravaged all continents. Dixon, McDonald and Roberts (2002) evaluated the macroeconomic impact of HIV/AIDS on African development. Their findings confirmed a negative effect on Africa's growth, with an estimated 2% to 4% reduction in average national economic growth rates. The contraction is due to two economic costs: first, the direct cost of lost labour and productivity, and second, the indirect cost of its prevention and treatment. Its prevalence had a variable impact, and political

and social stereotypes made it challenging to overcome its negative effects in many African countries.

Weil (2013) evaluated the impact of diseases like Malaria and AIDS on African economic growth. The author researched existing literature and provided a practical explanation for the policy challenges in Africa. The findings support the negative impact of disease on economic growth through the direct and indirect channels highlighted in the work of Dixon et al. (2012). Importantly, diseases that affect working-age people can lead to low labour productivity and an accompanying decline in income generation. Haacker (2008) evaluated the socio-economic impact of HIV/AIDS in Southern Africa and reported a negative impact on per capita income through a decline in productivity, human capital accumulation, and work experience.

The literature on the impact of epidemics and pandemics on socio-economic outcomes is limited at the micro-level. Nabyonga-Orem et al. (2008) conducted a descriptive quantitative and qualitative analysis of the impact of HIV/AIDS on household poverty status, informing poverty reduction strategies for Uganda. The study provides summary statistics on household income and other socio-demographic profiles from a cross-sectional household survey of 1,239 households, of which 602 were directly affected by HIV/AIDS. The findings revealed a reduction in household income for those affected by HIV/AIDS. At the micro-level, Chapoto and Jayne (2008) provided empirical analysis on the impact of HIV/AIDS-related prime-age deaths on household livelihoods in Zambia. Using a difference-in-difference estimation method, the results revealed a severe impact on the livelihoods of poorer households.

The economic impact of epidemics like the Severe Acute Respiratory Syndrome (SARS) epidemic also yield a disproportionate loss of household income for those engaged in

agricultural and rural employment activities. The Chinese economy, the largest one affected by the SARS virus, experienced a loss of 0.5% GDP as a consequence of the disease. It has been argued that the impact of SARS was amplified by economic status, weak infrastructure, and poor public health systems (Hanna and Haung, 2004). Brahmbhatt (2008) argued that the economic disruption from the SARS epidemic was linked more to panic and misinformation rather than the rate of infection or case fatality. Lee and McKibbin (2004) evaluated the mechanisms through which SARS influenced the global economy. The highlighted mechanisms included a reduction in consumer demand as a result of restricted social interactions. The second channel was uncertainty regarding the future economic outlook of the affected countries. The last channel emphasised the cost of preventing the spread of the disease on selected industries and economic sectors like retail, travel, and services.

An interesting piece of analysis on the impact of pandemics on socio-economic indicators is also provided in the work of Scheidel (2017), which was discussed in the previous chapter. The author recounted the ravaging diseases that emerged during the 17th to 19th centuries across Europe, the Americas, and the Middle East. The author also extended the focus to Africa. Irrespective of the direct impact of such diseases on human lives, the study examines their broader impacts on socio-economic indicators. The study analysed diseases, like chickenpox, smallpox, malaria, measles, influenza, and the black death, in an attempt to evaluate their social, economic, and political effects. The author documented systematic historical evidence confirming sharp contractions in resources and inequality that ultimately emerged after various historical pandemic episodes.

The EVD curtailment measures adopted in Sierra Leone find resonance in the fight against the current global pandemic (Covid-19). Social and economic restrictions have characterised the

fight against this deadly virus. The IMF have estimated that economic growth for emerging and developing economies will see a contraction of 1% in GDP (International Monetary Fund, 2020). Ongoing research has predicted a decrease in household income, especially in rural areas and those engaged in agricultural activity. Food insecurity will increase as a result of market distortions and transportation challenges. The economic downturn will be aggravated by curtailment policies based on movement restrictions and lockdowns (Wiggins et al., 2020). An evaluation of household income and food security in two East African countries (Kenya and Uganda) revealed that two-thirds of respondents reported a shock to their income as a result of Covid-19. Empirical analysis, undertaken using probit regression analysis, indicated a harder Covid-19 hit for poorer households more dependent on labour-intensive income activities. However, agricultural households incurred a smaller impact on their food security (Kansime et al., 2020).

The empirically well-established negative impacts of diseases and viruses at the macro level cannot provide a complete portrait for informing policies in combating the impact of diseases at the micro-economic level. Macro-economic growth indicators like GDP have limited use in shaping policies to mitigate the negative impact on households or individuals directly affected. Hence, a micro-level analysis of the impact of diseases on household welfare indicators (like poverty and inequality) can provide a better understanding to inform policy formulation and implementation. Thus, the current research evaluates the direct and indirect costs of a disease outbreak on household welfare. This research seeks to provide an empirical analysis of the EVD's impact on household welfare and its distribution in Sierra Leone. It also evaluates the household food security consequences of the virus outbreak. Overall, it adds to a literature on the economic impact of viruses that is too heavily centred around macro-economic outcomes.

4.4 Data and Variable Description

An empirical assessment of the impact of the Sierra Leone EVD outbreak on household poverty is undertaken using the 2018 Sierra Leone Integrated Household Survey (SLIHS) and data on Ebola cases per chiefdom compiled by Fang et al. (2016). This second dataset provides information on the number of confirmed and suspected cases for each chiefdom in Sierra Leone. The clinical data comprise a comprehensive dataset of EVD testing records for persons under investigation (PUIs) as reported by the Ministry of Health and Sanitation in Sierra Leone. A total of 8,358 confirmed cases were generated from the EVD testing records and mapped out to chiefdom level. The dates of the reports range from May 2014 to September 2015. The total number of chiefdoms with confirmed cases was 114 out of a total of 150 chiefdoms. The clinical data are presented with other individual characteristics by Fang et al. (2016) and are accessible from their website.[13] The data used here are based both on their research on the transmission dynamic of EVD and on the government intervention measures used in Sierra Leone to control the virus spread.

The 2018 SLIHS was conducted approximately two years after the end of the Ebola epidemic in Sierra Leone. The survey provides informative data on post-Ebola socio-economic household-level characteristics. This survey was conducted by Sierra Leone Statistics in conjunction with the World Bank, adhering to the standards of the World Bank's Living Standard Measurement Study (LSMS) and the Household Income and Expenditure Survey (HIES). It represents the third round of data collection in this series, with the first completed in 2003. The survey updated geographical references based on the 2015 Sierra Leone Population Census. The data collection was undertaken representatively across all chiefdoms

[13] See their website www.pnas.org/cgi/doi/10.1073/pnas.1518587113 for details of the data and a complete paper discussing the data.

and regions of the country. Sample stratification was by district and incorporated new district divisions. In 2017, a new district demarcation created a total of 14 districts, where previously there had just been 12. A total of 6,840 households were surveyed in the 2018 SLIHS.

The 2018 SLIHS is the most recent national survey conducted in Sierra Leone after the Ebola outbreak and is thus well suited to provide the basis for investigating the research questions in this chapter. The survey contains information on household aggregated consumption expenditures for food and non-food items. It provides other household characteristics relevant for assessing household welfare after the Ebola outbreak. In the context of this research, we use household consumption expenditure to construct poverty-related indicators and to provide a measure of overall household welfare. We follow the methodology proposed and defined by the World Bank and Statistics Sierra Leone in constructing both total and food poverty lines (see Statistics Sierra Leone/World Bank, 2019). Table 4.1 below describes the key outcome and treatment variables used in the empirical analysis.

The aim of this research is to empirically estimate the impact of the Sierra Leone Ebola outbreak on household poverty status, food security, and inequality. In so doing, we distinguish the impact of the virus on both objective and subjective measures of household poverty and on whether food needs are satisfied. The objective poverty measures are based on a monetary measure with household consumption providing the expenditure metric. The subjective poverty measures are based on non-monetary measures and broadly cover self-perceived welfare.

Table 4.1: Description of Dependent and Treatment Variables

	Variables	Description
Household Welfare	Household Total Expenditure	A continuous variable measuring the total household expenditure in thousands of Leones (local currency) on an annual basis.
	Household Food Expenditure	A continuous variable measuring the total household food expenditure in thousands of Leones (local currency) on an annual basis.
Objective Poverty	Poor	A dummy variable that takes the value 1 if household expenditure per capita is below the national poverty line, and 0 otherwise.
	Food	A dummy variable that takes the value 1 if household food expenditure per capita is below the national food poverty line, and 0 otherwise.
Subjective Poverty	Poor	A dummy variable that takes the value 1 if a household reports being poor relative to other households in their neighbourhood, and 0 otherwise.
	Food Insecurity	A dummy variable that takes the value 1 if a household reports difficulty (sometimes and always) in satisfying food demand in the last 12 months, and 0 otherwise.
Treatment	Ebola	A dummy variable that takes the value 1 if a chiefdom had confirmed Ebola cases, and 0 otherwise.
	Quarantine	A dummy variable that takes the value 1 if a chiefdom was subjected to the government quarantine, and 0 otherwise.

The log of household per capita expenditure is constructed by aggregating household food and non-food consumption expenditures per adult equivalent. We then use the household expenditure together with the estimated poverty lines in the local currency to assess households as either being below or above these lines.[14] A dummy variable is created for both absolute poverty and food poverty using the relevant poverty lines as benchmarks. Absolute poverty takes the value 1 if household per capita expenditure is below or equals the poverty line and 0 if not. Food poverty is also a 0/1 outcome variable which takes the value 1 for households with per capita food expenditure below or at the computed food poverty line and 0 otherwise. In addition to the above welfare indicators, an inequality measure is calculated based on the actual household expenditure using the concept of the Gini coefficient. How this is undertaken is discussed in more detail in the next section.

[14] The national poverty line was Le3,668,000 annually and the food poverty line was Le1,960,000 as of 2018.

In order to complement the analysis using these objective welfare measures, we also look at the impact of the Ebola outbreak on subjective measures of household poverty. As discussed by Ravallion (2012), subjective measures are less susceptible to measurement bias because they are non-monetary metrics; there is less hesitation to subjectively rank one's livelihood status than to provide information on one's actual income or expenditure levels. The survey includes information on how households assess their socio-economic status relative to their neighbours' standard of living. This relative self-assessed poverty question allows households to rank themselves as 'poor', 'average', or 'rich' as compared to other households in their neighbourhood. In a similar spirit, households were also asked about any difficulties encountered in the past 12 months in meeting their food needs. The response categories were 'never', 'sometimes', and 'always'. The analysis using this framework exploits responses across these categories to define whether households were exhibiting elements of food insecurity. Given the 12-month recall time, the answer 'always' is necessary but not sufficient to capture difficulty in meeting food needs. It is acknowledged that recall can bring about some bias in subjective poverty research. Hence, if a household can recall that sometimes in the previous 12 months they have experienced some lack of food needs satisfied, then they are considered food poor.

The 2018 SLIHS stratification is at the chiefdom level, which is the second smallest geographical division in Sierra Leone. This information is combined with scientific and clinical appraisal data on Ebola cases (both confirmed and suspected) at the chiefdom level (see Fang et al., 2016). The Ebola epidemic also prompted government curtailment policies like quarantines and restrictions on movement. The chiefdoms with high levels of Ebola cases and high contagion rates were quarantined. All regions in Sierra Leone experienced incidents of the virus but not all were subjected to the government quarantine policy. As discussed by

Coltart et al. (2017), the regions quarantined were characterised by poor control and management of the Ebola Control Centres and were thus overwhelmed with Ebola patients. The increasing cases necessitated the use of general medical wards, and with poor control, the infection rate spread as non-Ebola patients contracted the virus. They further established that the virus transmission was largely uncontrolled on long commuter roads, with small chains connecting networks of small villages. In September 2014, Freetown experienced sustained transmission from the eastern regions, and the high population density led to high infection rates. The health workers in Sierra Leone also went on strike due to poor working conditions, lack of payment, and the high fatality rate among front-line health workers. In partnership with international organisations, like Save the Children and the UK military, the Government of Sierra Leone opened Ebola Treatment Centres (ETCs) in urban areas to mitigate the transmission from Ebola patients transported to ETCs in the eastern regions. High-risk districts with fewer health workers and poor ETC facilities were subjected to lockdown, but not the more urban areas and the capital city. Nevertheless, the quarantine measures deterred movement from Ebola 'hot-spots' to non-Ebola-affected areas.

In order to capture the distinct nature of these two types of restriction, two separate Ebola treatment variables are constructed. The first is a dummy variable that takes the value 1 if a household was in a chiefdom that recorded confirmed cases of Ebola and 0 otherwise. The second is also a dummy variable assigned the value 1 if a household was in a chiefdom that was under government (or military) quarantine and 0 otherwise[15]. The aim of using the two separate approaches is to distinguish between the direct and indirect effects of Ebola. Direct effects are those associated with the presence of Ebola cases, while indirect effects are those

[15] The duration of the government quarantine measure ranged from 3 weeks to a maximum of 4 months in some districts, especially Kenema in the east. However, the government enforced the same restriction for all quarantined chiefdoms. The average quarantine period per affected chiefdom was about 3 months. This helped stabilise the disease spread given the dynamic patterns discussed in Fang et al. (2016).

from policies restricting economic and non-economic movement as a result of the Ebola epidemic in Sierra Leone. This research aims to analyse whether the epidemic's effects on household welfare indicators were driven by the curtailment policies or more directly through the Ebola infections themselves.

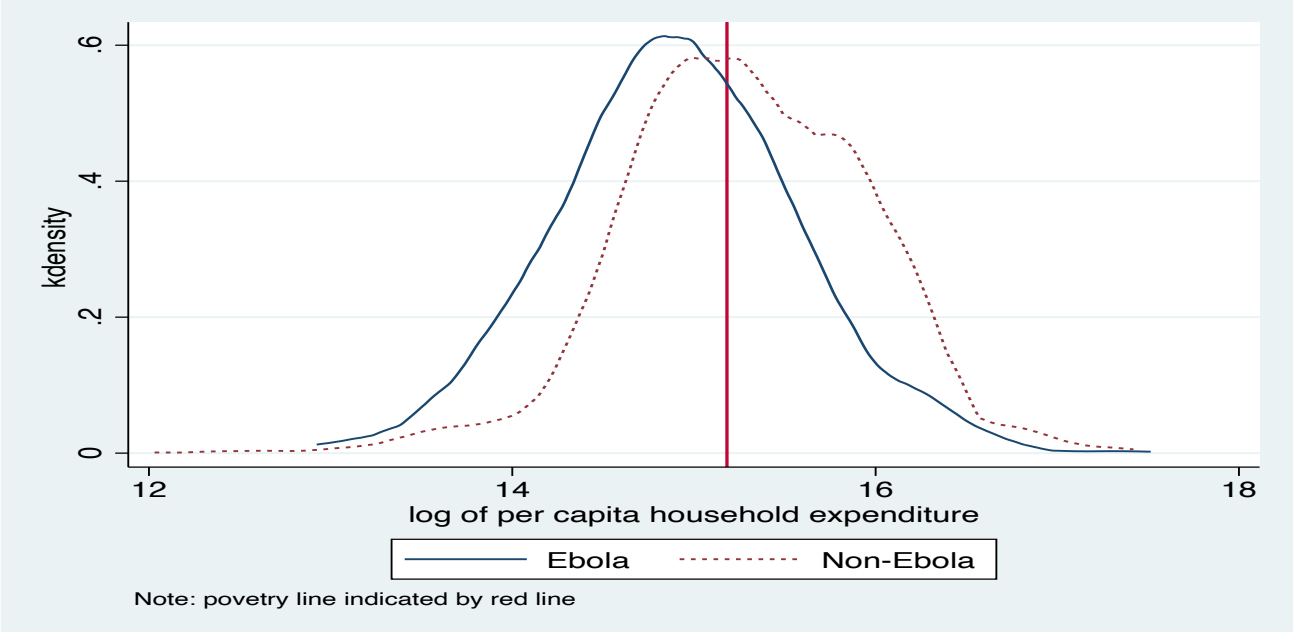
The household survey contains relevant household characteristics that inform on the demographic profile of households. The age of the head of household and their education, employment, marital status, ethnic status, and religious affiliation comprise some of the information used in this analysis. A number of asset indicators are also constructed from the data (see below). In addition, household size, dependency ratio, settlement type, and location are also variables used that inform on general household wellbeing.

This chapter also used the 2011 SLIHS to provide comparable estimated effects for the selected welfare indicators pre-Ebola. This is the only available household survey that pre-dates the Ebola outbreak for Sierra Leone. It provides a description of the household welfare indicators before the Ebola outbreak and potentially allows for more confidence in the causal identification of the Ebola outbreak's impact on household welfare reported here.

4.5 Descriptive Statistics

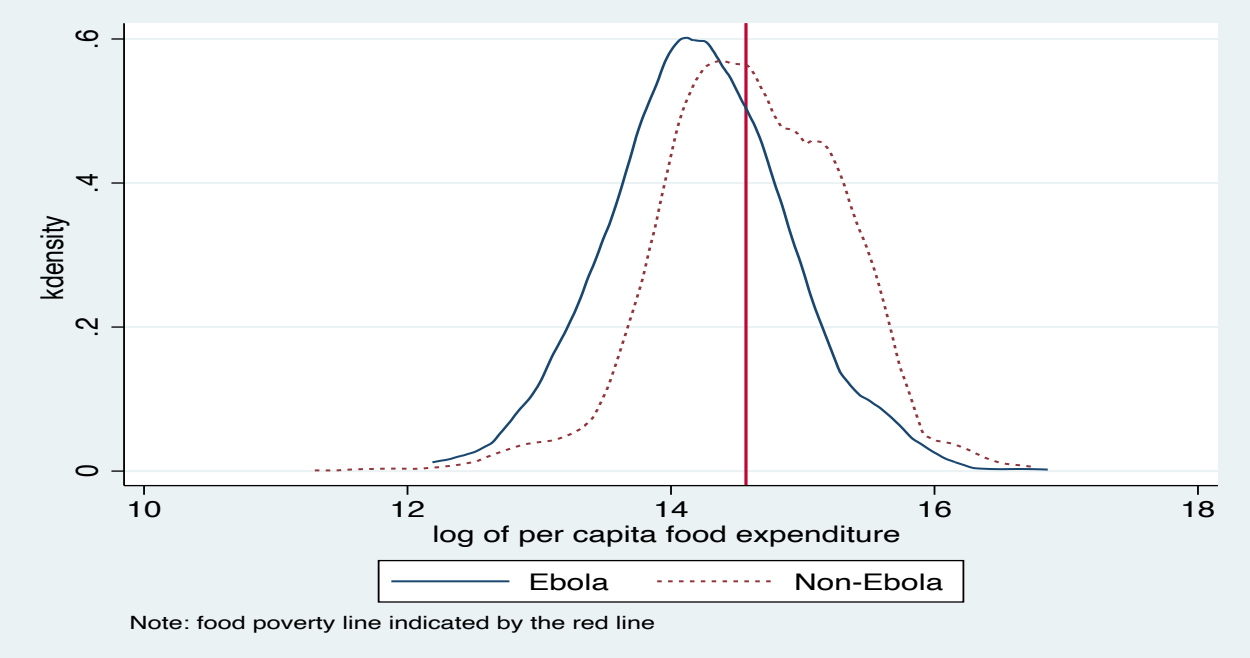
The distribution of household expenditure across the Ebola-affected and non-Ebola-affected chiefdoms for both total and food household expenditures are presented in Figures 4.2 and 4.3, respectively. In Figure 4.2, the log of total per capita expenditure has a greater distribution of households to the left of the poverty line for chiefdoms with Ebola cases as compared to those where Ebola cases were absent.

Figure 4.2: Log of per Capita Household Expenditure by Ebola Status in 2018



The area under the solid line (Ebola) is greater than the area under the dotted line (Non-Ebola), indicating that there were more Ebola than Non-Ebola households in poverty. The food expenditure distributions for Ebola and Non-Ebola households are broadly similar to those depicted in Figure 4.2 (see Figure 4.3). However, the food expenditure difference across areas is slightly less pronounced than that for total expenditure. Overall, however, both figures reveal a negative correlation between Ebola cases at the chiefdom level and these two types of household expenditures.

Figure 4.3: Log of per Capita Household Food Expenditure by Ebola Status in 2018



Districts that were severely affected by Ebola cases and contagion, and thus subject to government quarantine measures, also exhibit a sharp difference compared to the non-quarantine districts. This is depicted in Figures 4.4 and 4.5 for total and food expenditures, respectively (with the poverty line also imposed). In Figure 4.4, the area under the solid line to the left of the poverty line is larger than that under the dotted line. The total household expenditure distribution is different between quarantine and non-quarantine households. Similar distributions are evident in Figure 4.5 regarding the household food expenditure metric. The pattern for both total and food expenditure with respect to government quarantine measures reveals a sizeable change in household expenditures for both affected areas. This again suggests a negative correlation between the quarantine policy and household welfare. There are more households falling into poverty post-Ebola in those areas that were subject to the quarantine policy.

Figure 4.4: Log of per Capita Household Expenditure by Quarantine Status in 2018

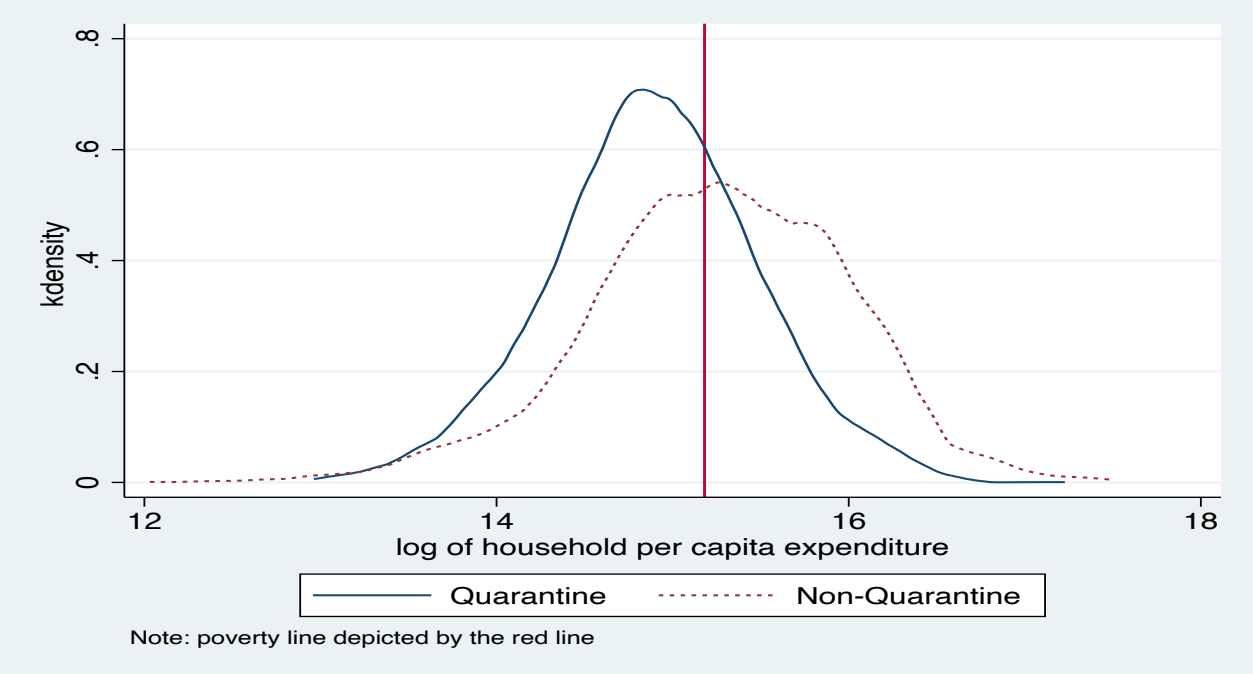
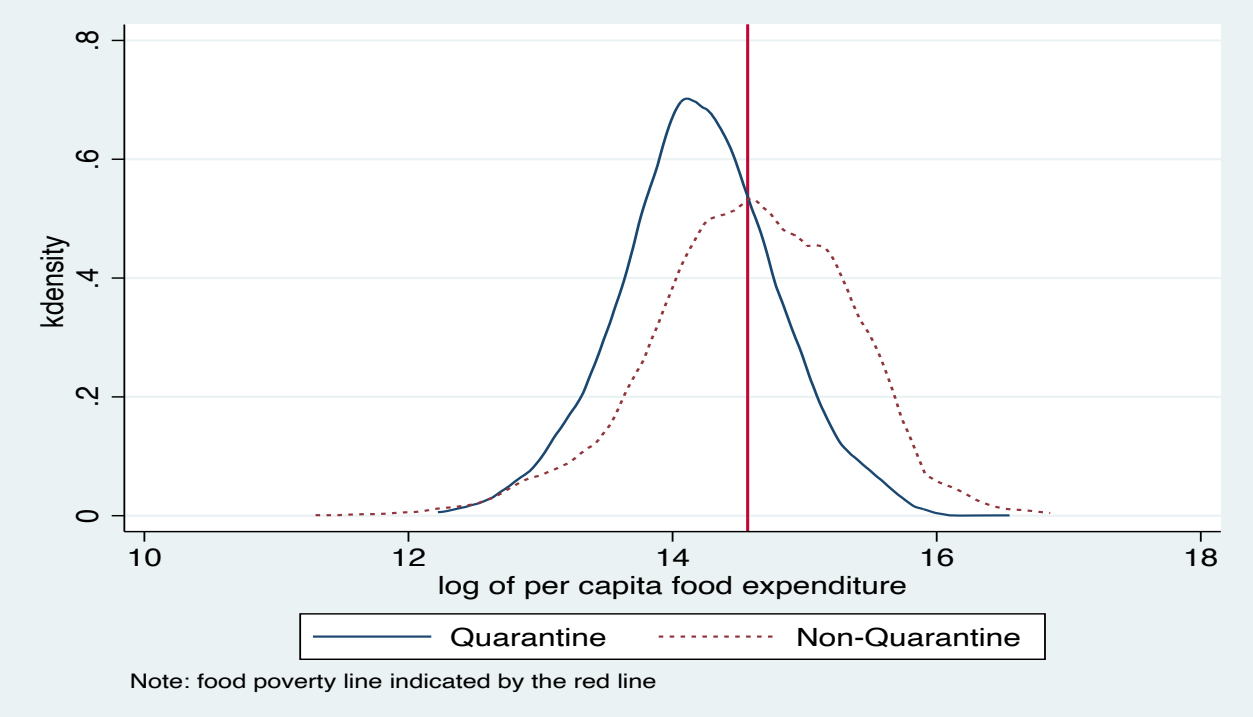


Figure 4.5: Log of per Capita Food Expenditure by Quarantine Status



Our attention now turns to Table 4.2, which provides summary statistics of household objective poverty by Ebola and quarantine status informed by the above plots. Overall poverty and food

poverty stood at 57% and 54% respectively two years after Sierra Leone was declared Ebola-free. There was a 21 percentage-point difference in total and food poverty rates between households in chiefdoms with confirmed Ebola cases and those in unaffected chiefdoms.

Table 4.2: Summary Statistics of Household Poverty by Ebola and Quarantine Status (2018)

		Ebola			**Quarantine**		
	Overall	Ebola	Non-Ebola	Differential	Quarantine	Non-Quarantine	Differential
Objective Poverty							
Poor	0.5679***	0.6751***	0.4624***	0.2127***	0.7087***	0.4576***	0.2511***
	(0.0060)	(0.0081)	(0.0085)	(0.0118)	(0.0083)	(0.0081)	(0.0118)
Food	0.5352***	0.6447***	0.4274***	0.2173***	0.6905***	0.4135***	0.2770***
	(0.0061)	(0.0083)	(0.0085)	(0.0118)	(0.0085)	(0.0080)	(0.0118)
Subjective Poverty							
Poor	0.5301***	0.6480***	0.4142***	0.2337***	0.6220***	0.4581***	0.1639***
	(0.0061)	(0.0083)	(0.0084)	(0.0118)	(0.0089)	(0.0081)	(0.0121)
Food Insecurity	0.5445***	0.5568***	0.5323***	0.0245***	0.5624***	0.5305***	0.0319
	(0.0061)	(0.0085)	(0.0086)	(0.0085)	(0.0091)	(0.0081)	(0.0212)
Samples	**6738**	**3339**	**3399**		**2956**	**3782**	

Note: standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

The findings for the objective food poverty measure comport with the total expenditure poverty measure for Ebola status. This narrative is broadly similar for the national quarantine policy status but suggests a wider differential of between 25 and 27 percentage points for total and food poverty, respectively. In terms of subjective measures of poverty and food insecurity, more households assessed themselves as poor relative to their neighbours for both the Ebola and quarantine status treatments. The proportion of households falling into poverty is higher in areas affected by Ebola, due to both the cases themselves and the quarantine status. This is true both for objective poverty and for households' self-assessments of their economic status relative to their neighbours as well as in meeting their daily food needs. In comparison to the poverty outcomes in 2011, the quarantined areas experienced higher objective poverty and

reported higher food insecurity levels. The pre-Ebola differences are depicted in Table 4.3 below.

Table 4.3: Pre-Ebola Statistical Differences in Objective and Subjective Poverty (2011)

	EBOLA			QUARANTINE		
Variable	Ebola	Non-Ebola	Differential	Quarantine	Non-Quarantine	Differential
Objective Poverty						
Total Poverty	0.6561***	0.4375***	0.2186***	0.6916***	0.4747***	0.2168***
	(0.0073)	(0.0100)	(0.0122)	(0.0082)	(0.0083)	(0.0118)
Food Poverty	0.4241***	0.3398***	0.0842***	0.4541***	0.3399***	0.1142***
	(0.0076)	(0.0096)	(0.0123)	(0.0089)	(0.0079)	(0.1191)
Subjective poverty						
Poor	0.6152***	0.5319***	0.0833***	0.5800***	0.5885***	-0.0085
	(0.0074)	(0.0101)	(0.0124)	(0.0088)	(0.0082)	(0.0121)
Food Insecurity	0.7245***	0.6532***	0.0712***	0.7422***	0.6603***	0.0822***
	(0.0068)	(0.0096)	(0.0116)	(0.0078)	(0.0079)	(0.0112)
Samples	**4177**	**2507**		**3100**	**3568**	

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

In addition, as depicted in Figure 4.6, the distribution of household expenditure shows more households with low expenditure in the quarantined chiefdoms. The proportion of quarantined households below the poverty line is greater than that of non-quarantined households. Our preferred estimates centre on the national government quarantine measures. The curtailment measure acted as a strong impediment to the virus's spread but also impacted economic and social mobility. It is also worth noting that the pre-Ebola quarantined chiefdoms also appear to have had a disadvantageous socio-economic position prior to the spread of the Ebola virus.

The same is confirmed for chiefdoms with confirmed Ebola cases. The pre-Ebola quarantined chiefdoms had no significant difference in inequality on the basis of the total and food expenditure Gini coefficients. The pre-Ebola (both total and food) levels suggest a negative gap between the quarantine and non-quarantined chiefdoms (see Table A4.3 in the appendix). Thus, the pre-Ebola differences in objective poverty indicate historical rather than Ebola-related differences. From this contextualisation, it appears that the Ebola-affected regions were

among the poorest regions in the country and had a history of disease susceptibility. They were rural areas whose populations possessed strong traditional beliefs and engaged in indigenous social practices. These populations shared strong beliefs regarding caring for the sick and washing dead bodies, as well as a preference for traditional medicine. Paul (2016) explained how culture and social norms helped the spread of Ebola in rural areas. Nevertheless, there was no evidence of a difference in subjective poverty rates by quarantine status pre-Ebola (see Table 4.3).

Figure 4.6: Pre-Ebola (2011) log of Household Total Expenditure by National Quarantine Status

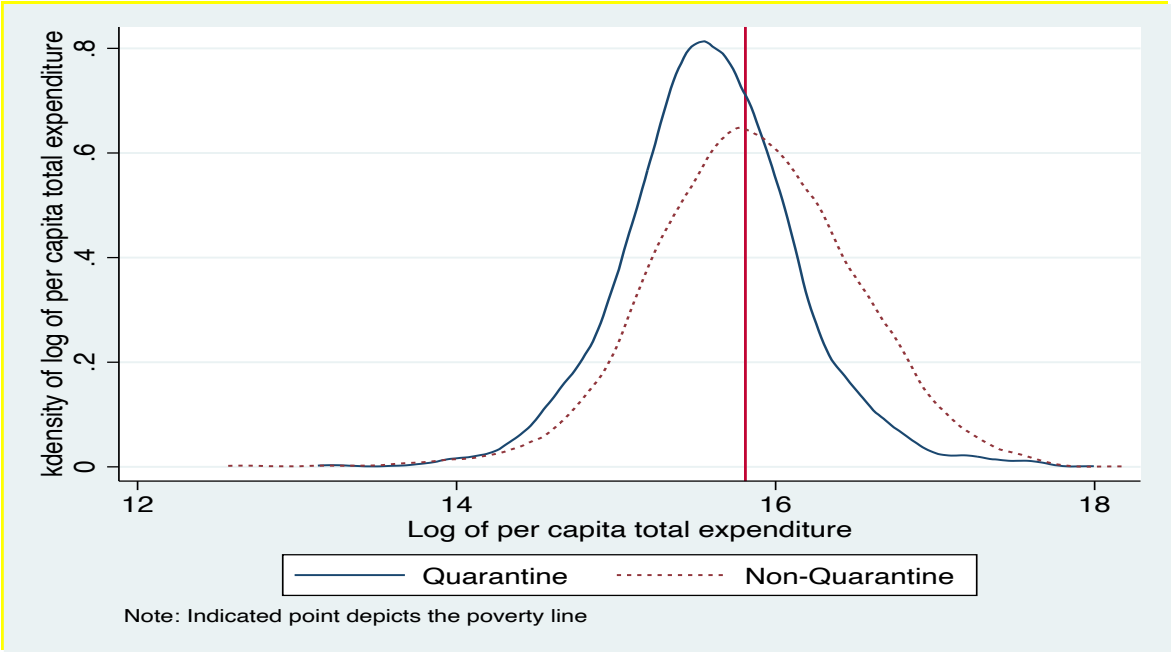


Table 4.4 below reveals that the virus and the quarantine policies exhibit a heterogeneous impact on household expenditure across selected percentiles of the unconditional log expenditure distribution. Households across the different expenditure quantiles experience reductions across both total and food expenditure categories. However, households in chiefdoms that reported confirmed cases register a larger impact at the bottom end of the expenditure distribution. At the top end of the distribution there is little statistical difference

between the two treatments. The effects appear broadly comparable here. Household inequality measured by the expenditure Gini does not reveal any statistical differences for those households in chiefdoms with or without reported Ebola cases. However, the quarantined households are subject to a reduced level of inequality two years after the end of the epidemic. The raw statistics again confirm a negative association between Ebola and the various household welfare indicators.

Table 4.4: Summary Statistics of Household Welfare Indicators by Ebola and Quarantine Status (2018)

		Ebola			**Quarantine**		
	Overall	Ebola	Non-Ebola	Raw Diff	Quarantine	Non-Quarantine	Raw Diff
Log of per capita Total Expenditure							
Total	16.6495	16.444	16.852	-0.408***	16.494	16.772	-0.278***
				(0.015)			(0.016)
Food	15.9604	15.743	16.175	-0.432***	15.792	16.093	-0.301***
				(0.016)			(0.016)
Log of per capita Total Expenditure by Percentiles							
10th	15.7747	15.554	15.992	-0.437*** (0.043)	15.658	15.867	-0.209*** (0.044)
25th	16.2718	16.105	16.436	-0.332***	16.122	16.39	-0.268***
				(0.019)			(0.019)
50th	16.6343	16.404	16.861	-0.456***	16.506	16.736	-0.230***
				(0.018)			(0.019)
75th	17.0947	16.878	17.308	-0.430*** (0.021)	16.891	17.255	-0.364*** (0.021)
90th	17.5529	17.377	17.726	-0.350***	17.330	17.729	-0.399***
				(0.020)			(0.020)
Gini Coefficients							
Total	0.3454	0.348	0.343	0.006	0.323	0.363	-0.041***
				(0.006)			(0.006)
Food	0.3552	0.359	0.351	0.008	0.332	0.374	-0.042***
				(0.006)			(0.006)
Samples	**6738**	**3339**	**3399**		**2956**	**3782**	

Note: standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Overall, the areas most affected by Ebola appear to be poorer than those less affected by the disease. This highlights the importance of a careful interpretation of the raw data reported here. Some of the association between Ebola and household welfare noted in 2018 reflects the role

of underlying factors that rendered some chiefdoms more susceptible to the spread of the disease. Thus, the objective of the research undertaken in this essay is to establish the causal impact of both Ebola and the quarantine policy on household welfare, which goes beyond the analysis of a statistical association between these two variables. The empirical framework used for this purpose is discussed in the next section.

Table 4.5: Summary Statistics of Household Characteristics by Ebola and Quarantine Status (2018)

		Ebola			Quarantine		
Variable	**Overall**	Ebola	Non-Ebola	**Differential**	Quarantine	Non-quarantine	**Differential**
Household characteristics:							
Head's age	47.0867	47.7935	46.3906	1.403***	46.4100	47.9460	-1.535***
Household size	7.1236	7.1135	7.1337	-0.020	6.8410	7.4840	-0.643***
Dependency ratio	1.7571	1.6466	1.8657	-0.219***	1.8030	1.6990	0.104***
Female head	0.2630	0.2719	0.2542	-0.017**	0.2650	0.2610	0.004
Head's education:							
No education	0.5242	0.6532	0.4894	0.164***	0.4680	0.5950	-0.126***
Primary	0.1409	0.0995	0.1815	-0. 080***	0.1650	0.1100	0.055***
Secondary	0.2148	0.1655	0.2633	-0.0978***	0.2230	0.2050	0.018*
Higher	0.1202	0.0818	0.1579	-0.0761***	0.1440	0.0900	0.053***
Employment status:							
Self-employed	0.1801	0.0794	0.2791	-0.200***	0.2130	0.1380	0.075***
Farm	0.4160	0.5778	0.2568	0.321***	0.3530	0.4960	-0.143***
Unemployed	0.1220	0.1117	0.1322	-0.021***	0.0980	0.1520	-0.054***
Other	0.2819	0.2311	0.3319	-0.101	0.3360	0.2140	0.122***
Head's Marital status:							
Married	0.6073	0.6766	0.5391	0.138***	0.5910	0.6280	-0.038***
Single	0.3299	0.2714	0.3875	-0.116***	0.3380	0.3190	0.019*
Other	0.0139	0.0149	0.0129	0.002	0.0110	0.0030	0.008***
Cohabit	0.0074	0.0039	0.0109	-0.007***	0.0110	0.0170	-0.006**
Head's religion:							
Christian	0.1466	0.1132	0.1795	-0.066	0.1520	0.1390	0.013
Muslin	0.5729	0.5754	0.5705	0.005	0.5650	0.5830	-0.018
Other	0.2805	0.3114	0.2500	0.061	0.2830	0.2770	0.005
Settlement Type							
Urban	0.5474	0.3447	0.7470	-0.402***	0.6120	0.4650	0.147***
Other household facilities							
Electricity	0.2703	0.1341	0.4042	-0.270***	0.3310	0.1930	0.137***
Number of rooms occupied	3.5828	3.8723	3.2987	0.574***	3.2430	4.0180	-0.774***
Agricultural Land Access							
Land size in hectare	0.8516	0.8749	0.8516	-0.023	0.7640	0.9940	-0.229***
Durable asset	0.1420	0.1442	0.1398	0.004	0.1400	0.1440	-0.003
Principal components:							
Housing characteristics	0.5132	-0.2210	0.2175	-0.4385***	0.1540	-0.1970	0.351***
Amenities characteristics	-0.0093	0.0094	-0.0093	0.0187	0.0050	-0.0060	0.011
Sample Sizes	**6738**	**3339**	**3399**		**2956**	**3782**	

*** p<0.01, ** p<0.05, * p<0.1
Standard errors not reported

As noted earlier, the 2018 SLIHS also provides detailed information on additional household and socio-economic characteristics. The total number of households used in the analysis is 6,738, with approximately 50% resident in chiefdoms that recorded Ebola cases. Quarantine households accounted for 44% of households in the survey.

The characteristics are presented in Table 4.5, with differences by Ebola status reported. On the basis of Table 4.5, households in chiefdoms with recorded Ebola cases have younger heads, more female heads, and lower dependency ratios. The quarantine households have similar characteristics, but higher dependency ratios. There are a significant number of heads with no education in the Ebola-affected areas. Educational background is significantly different by Ebola status. Households involved in agricultural activities are more prevalent in Ebola-affected regions than in quarantined chiefdoms. Marital status differs by Ebola status, but there are no statistically significant religious differences detected here.

There are more households in urban areas in chiefdoms that did not report Ebola cases, but this is not so for the quarantined chiefdoms. Ebola cases were more prevalent in rural areas, and electricity access was lower in the Ebola case areas than in the quarantined areas. The population density and economic activities in urban areas might have been a cause of contagion and hence warranted the imposition of a government quarantine. Economic amenities like electricity and access to social facilities like hospitals and markets were available and maintained for quarantined households. There are no significant differences in terms of household durable assets. However, housing and amenity characteristics, which are measured using principal components, only reported a significant difference for housing characteristics across both treatments, though the sign of magnitudes of the differentials are reversed (see

Table A4.2 for the variables used in constructing the principal component measures). Individual household head characteristics are found to be similar for both treatment variables. There is some evidence that the Ebola impact was random across the set of individual and household characteristics. In addition, according to the Ebola Response Unit report, there is no evidence of a disproportionate impact of the disease based on ethnic group affiliation (Statistics Sierra Leone, 2015).

The above variables comprise the input or explanatory variables that may assist in determining potential causal impacts of the Ebola outbreak and the government quarantine policy in Sierra Leone on household welfare. The next section of this chapter describes the empirical methodologies used to evaluate the impact of Ebola and the quarantine policy on household welfare in Sierra Leone.

4.6 Econometric Methodology

We first explore some descriptive econometric analysis examining the impact of both Ebola and the quarantine policy on household welfare metrics and food security using a variety of regression models. For the analysis of poverty, the descriptive analysis uses a binary (0/1) dependent variable. Using the poverty lines highlighted in the data section, households are assigned 1 if below the poverty line and 0 otherwise. A probit regression model is then specified as follows:

$$\text{prob}[\text{poverty}_i = 1] = \Phi(\alpha + \beta\text{Ebola}_i + \boldsymbol{\gamma}\mathbf{X_i}) \qquad [4.1]$$

where $\Phi(.)$ is the cumulative distribution function operator for the standard normal; poverty_i is a binary variable that represents whether the i^{th} household is at or below the total poverty or food poverty line; Ebola_i captures either of the two Ebola-related treatments (i.e., either households in chiefdoms that recorded confirmed cases of Ebola or households in chiefdoms with government quarantine policies imposed in response to Ebola); and $\mathbf{X_i}$ is a vector for the i^{th} household that includes realisations for household covariates relating to, *inter alia,* the head's age, education, marital status, and religion, and further comprises household size, settlement type, access to basic amenities, dwelling characteristics, and living conditions (see Table 4.4 above for more detailed descriptions of these variables).

In addition to a binary poverty measure, we also use the underlying continuous measure for log household expenditure. The estimation of the impact of Ebola on household expenditure is obtained from the following specification:

$$\text{welfare}_i = \alpha + \beta\text{Ebola}_i + \boldsymbol{\gamma}\mathbf{X_i} + \varepsilon_i \qquad [4.2]$$

where welfare_i represents a variety of continuous logged indicators of welfare for each household (i.e., log per capita household expenditure or log per capita food expenditure); Ebola_i, our main treatment variable of interest, represents households in chiefdoms that either recorded confirmed cases of Ebola or were subjected to the government quarantine policy; and $\mathbf{X_i}$ are household characteristics viewed as relevant determinants of household welfare as defined earlier for [4.1] above. The equations described by [4.2] are initially estimated by OLS.

The impact of Ebola (or the quarantine policy) at different quantiles of the household welfare distribution is evaluated using unconditional quantile regressions based on Recentred Influence Functions (RIFs). This approach is now outlined. Assume IF(y;ν) is the influence function corresponding to an observed outcome variable y and the distributional statistic is defined as $\nu(F_y)$. Assume the RIF corresponding to this case is defined as RIF(y; ν) where y is the log of household expenditure (either total or food):

$$\text{RIF}(y; \nu) = \nu(F_y) + \text{IF}(y; \nu) \qquad [4.3]$$

For distributional statistics like quantiles, the IF is defined as:

$$\text{IF}(y; Q_\tau) = (\tau - I[y \leq Q_\tau]) \div f_y(Q_\tau) \qquad [4.4]$$

where τ is the quantile of interest, I(·) is an indicator function assuming a value of 1 if the expression in parentheses is satisfied, Q_τ is the population quantile of the τ^{th} quantile of the unconditional distribution of y, and $f_y(Q_\tau)$ is the density of the marginal distribution of the outcome variable evaluated at Q_τ. The corresponding RIF is then expressed as:

$$\text{RIF}(y; Q_\tau) = Q_\tau + (\tau - I[y \leq Q_\tau]) \div f_y(Q_\tau) \qquad [4.5]$$

The Firpo et al. (2009) RIF regression model is then defined as:

$$E[RIF(y; Q_\tau) \mid \mathbf{X}] = \boldsymbol{\beta}\mathbf{X_i} \quad [4.6]$$

where the RIF is assumed to be a linear function of the covariates originally specified in [4.2] above but now defined as contained in **X**. This expression can be estimated by OLS. Firpo et al. (2009) show that such an OLS regression provides estimates for **β** that represent the effect of the x covariates on the unconditional τ^{th} quantile of the outcome variable y. This is why the authors refer to an equation like [4.6] as an unconditional quantile regression.[16]

As a prelude to the estimation of equation [4.6] by OLS, the RIF expression [4.5] needs to be computed. This emphasises a conceptual difference between the conditional and the unconditional quantile regression approach. In the former case, the specification of the covariates determines the quantile (given it is conditional on the covariates contained in the specification) but in the latter case the quantile is independent of the covariates used as it is computed pre-regression.

The expression [4.5] is unobserved in practice, so the corresponding sample analogues are used. This requires computing the sample $\hat{Q}_\tau$ and then estimating the density value at this point $\hat{f}(\hat{Q}_\tau)$ using non-parametric kernel density methods. An estimate of the RIF for each observation is then obtained by plugging the density estimates into expression [4.5]. It is the multiplication of the probability by the inverse of the density that yields the quantile values in this case. The approach is known in the literature as the 'plug-in' method. Thus, this procedure changes the outcome variable at each quantile in expression [4.5] in such a way that the mean of the recentred function corresponds to the quantile.

In summary, the RIF-OLS regression approach involves the following steps:

[16] It is the case that if the RIF in [4.6] is recast in terms of the mean statistic, the application of OLS yields mean regression estimates identical to those obtained by OLS using the untransformed outcome variable y.

1. Estimate a linear probability model for being above the quantile of interest (Q_τ).

This estimation procedure yields estimated marginal (for continuous variables) and impact (for dummy variables) effects expressed in probability units.

2. Divide these marginal/impact effects by the kernel (probability) density evaluated at the quantile of interest.

This locally inverts the (unconditional) probability effects into (unconditional) quantile effects. The estimator of the density for y is obtained using a kernel density estimator. Define $K_y(z)$ to be a kernel function and b_Y a positive scalar bandwidth. The kernel density estimator is defined for quantile Q_τ as:

$$\hat{f}_Y(\widehat{Q}_\tau) = \frac{1}{N \times b_y} \sum_{i=1}^{N} K_y \left(\frac{y_i - \widehat{Q}_\tau}{b_Y} \right) \quad [4.7]$$

where $K_y(z)$ can be from a choice of kernel densities (e.g., Gaussian or Epanechnikov) and the bandwidth (b_y) is set in advance (e.g., 0.1). We choose the appropriate weight from the estimated kernel density for the relevant quantile. The estimated scaling factor $\frac{1}{\hat{f}_y(\cdot)}$ is then used to invert the probability effects back to the relevant quantile effects. We re-express the equation [4.6] as follows given the focus on Ebola:

$$E[RIF(y_i;\ Q_\tau)|X, Ebola] = \boldsymbol{\beta X_i} + \alpha Ebola_i \quad [4.8]$$

The main regression model (equation 4.8) is estimated by OLS and the estimates provide the effect of the covariates on the unconditional quantile of interest. The selected quantiles in this case comprise the 10th, 25th, the median, the 75th, and the 90th percentile. This regression model enables us to determine the impact of Ebola or government quarantine at different points of the unconditional log distribution of the household welfare measure used in the analysis.

The impact of Ebola on household inequality using the Gini coefficient is also explored through using the Recentred Influence Function (RIF). Firpo, Fortin, and Lemieux (2009) developed this influence function (IF) concept to go beyond the mean (as with the unconditional quantiles above) and extended it to other distributional statistics like variances and the Gini coefficient. Essamah-Nssah and Lambert (2011) outlined how the RIF concept can be applied to the Gini coefficient. In this context, the RIF for the Gini coefficient is used and will enable us to examine the impact of Ebola on the distribution of household inequality as measured by the RIF-based form of the Gini coefficient. As noted in Essay 2 of this thesis, the RIF-based Gini can be expressed systematically as an approximate linear relationship with the selected household and Ebola treatment as in the equation above. Specifically, we regress the RIF-based Gini coefficient measure on a set of household covariates ($\mathbf{X_i}$) and the Ebola treatment variables (Ebola_i) using a standard OLS approach to determine the Ebola impact on inequality using an equation as described below:

$$\text{E}[\text{RIF}(\text{y}_\text{i};\ \text{Gini})|\text{X}, \text{Ebola}] = \boldsymbol{\gamma}\mathbf{X_i} + \alpha\text{Ebola}_\text{i} \qquad [4.9]$$

The impact of the Ebola outbreak (both through Ebola cases and quarantine status) on subjective welfare is also investigated in this chapter through the use of two categorical variables based on self-assessed poverty and food insecurity. Household poverty is self-defined relative to neighbours' living standards as belonging to one of three categories (i.e., poor, average, and rich). The second subjective welfare dimension is food insecurity, which assesses a household's ability to meet their food needs within the last 12 months. Households self-reported their difficulties using the terms 'always', 'sometimes', and 'never'. In this case, the empirical analysis constructs subjective welfare outcomes for food insecurity and poverty from the responses to these self-assessed questions. The subjective outcome is a dummy variable

taking the value 1 if a household reports being poor relative to its neighbours' standard of living and takes the value 0 otherwise. In the same vein, food insecurity is a dummy variable that takes 1 if a household reports either 'always' or 'sometimes' having difficulty in meeting its food needs in the last 12 months and 0 otherwise. Hence, if a household can recall experiencing difficulty in meeting its daily food needs, it is classified as food insecure. A binary dependent subjective poverty variable is used as opposed to an ordinal measure. This provides a comparable measure to the objective poverty dependent variable used in expression [4.1]. As presented in table 3.2, the raw averages are similar for both objective and subjective poverty measures. A probit model is then specified as follows:

$$\text{prob}[\text{subjective welfare}_i = 1] = \Phi(\alpha + \beta \text{Ebola}_i + \mathbf{X_i}\boldsymbol{\gamma}) \qquad [4.10]$$

where subjective welfare is the dummy variable for either subjective poverty or food insecurity as discussed in this section. Ebola_i and the covariates included in the $\mathbf{X_i}$ vector are as defined earlier.

It is acknowledged that the above analysis, while informative, is largely descriptive in nature. In order to estimate a causal impact of Ebola on household welfare, poverty, and food insecurity, we expand our methodologies to include the propensity score matching (PSM) technique. This enables the estimation of the average treatment effect of the Ebola epidemic on household expenditure, poverty (subjective and objective), and food insecurity. This is potentially important in the current context because the more adversely affected chiefdoms were those with poorer socio-economic profiles. In order to obtain the causal effects, we again use the PSM approach. This enables the estimation of the average treatment effect of Ebola or

the quarantine policy on the treated households in terms of the selected welfare indicators discussed above.

As extensively discussed in the two earlier essays of this thesis, the PSM methodology allows for the simulation of randomly allocated households into treatment and control groups based on their propensity scores, which are derived from a treatment assignment equation estimated using a binary logit regression model. The included covariates in the treatment assignment equation influence household welfare indicators and the treatment but are not affected by the treatment itself (i.e., Ebola-affected chiefdoms or quarantine status). The included covariates are the same welfare determinants or input variables used in the various equations specified above. Given the nature of Ebola, it provides a natural experiment that leads to the division of households into control and treatment groups. The PSM provides the framework for computing the average treatment effect on the treated of the Ebola outbreak in terms of both cases and the quarantine policy.

Treatment contamination from spill-overs from the control group has the potential to undermine the internal validity of our estimation. In terms of the quarantine measures, the national curtailment policies were strongly managed with military checkpoints, and curfews were extensively used. This impeded movement from the control to the treatment chiefdoms. In addition, there is generally only a single route connecting chiefdoms, which renders the use of checkpoints effective in mitigating spill-over effects. The national quarantine was imposed at the chiefdom level, thus putting an entire chiefdom under lockdown regardless of the level of case exposure.

4.7 Empirical Results

The empirical results are now presented, starting with the impact of the incidence of Ebola cases on household objective poverty (total and food). This is then followed by a discussion of the Ebola impact on log per capita household expenditure, its distribution, and finally its effect on the household Gini coefficient. The analysis is then extended to the quarantine policy. The estimated results from the probit, OLS, RIF-quantile, and RIF-Gini specifications will form the first sets of descriptive estimates for interpretation and discussion.

Table 4.6 presents the results of the probit estimates (equation 4.1) on the determinants of household poverty, including households in chiefdoms that reported confirmed cases of Ebola. The first and second columns comprise the probit impact effects on objective (total and food) poverty for households in chiefdoms with reported Ebola cases. The last two columns include the impact effects of the Ebola Quarantine policy.

Table 4.6: Probit Impact Effects of Ebola on Household Objective Poor and Food Poverty by Ebola and Quarantine Status (2018)

	Ebola		Quarantine	
VARIABLES	**Poor**	**Food**	**Poor**	**Food**
Ebola	0.0260*	0.0610***	0.2000**	0.2330***
	(0.0150)	(0.0140)	(0.0140)	(0.0130)
Pseudo R^2	**0.1956**	**0.1477**	**0.1960**	**0.1481**
Observations	**6738**	**6738**	**6738**	**6738**
Household & Other Controls	**Yes**	**Yes**	**Yes**	**Yes**

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
The regression estimations control variables are household characteristics like head's age, gender, education, employment, religion, and marital status. Additionally, the control variables include settlement areas, household facilities like electricity access, durable assets, and the number of rooms occupied. Agricultural land access and indices of household dwelling and amenities form part of the regression controls.

The estimate in the first column of Table 4.6 suggests that Ebola increased objective poverty by 2.6 percentage points, on average and *ceteris paribus,* though the estimate is only statistically significant at the 10% level using a two-tailed test. In contrast, household food poverty increased by a more well-determined 6.1 percentage points. The estimated impact

effect from the probit analysis is on the modest side compared to the raw differences of 21 percentage points for both food and total poverty reported earlier in Table 4.2. This suggests that most of the difference is actually driven by endowment differences between Ebola-affected chiefdoms and unaffected chiefdoms rather than through the influence of the Ebola disease itself. Thus, the magnitude of the Ebola effect on poverty is actually relatively modest in magnitude.

The last two columns present the analysis of the effects on poverty of the government quarantine policy imposed to curtail the Ebola outbreak. In contrast to the first set of estimates discussed above, the impact of the Ebola quarantine is sizeable compared to that associated with having confirmed cases. The effect of the quarantine policy yields a 20.0 and 23.3 percentage-point increase in total and food poverty, respectively. This delineation of households by quarantine status suggests a stronger impact on household poverty status. The raw differentials observed are thus not now driven by differentials in household or chiefdom characteristics but by the quarantine policy. The policy introduced restrictions on both social and economic behaviour. Markets were closed and the restrictions on movement reduced employment, largely within the informal sector. The national government mobilised the distribution of food for individuals in Ebola case centres and Ebola-affected households (Statistics Sierra Leone, 2016) and this may explain why the Ebola-affected chiefdoms report lower estimated effects of the disease. As discussed by Coltart et al. (2017), the quarantine policy was centred around factors that actually exacerbated the poor welfare conditions of households as economic activities were cut-off. In general, the quarantined districts had weak health systems, poor trust in national governance, a lack of vehicle and motorable road access to remote sites, shortages of health care workers, and a lack of community engagement (Coltart et al. (2017).

Table 4.7: OLS Regression on the Determinants of Log Household Expenditure and its Distribution (2018)

	Log Expenditure and Gini			Log Expenditure Percentiles				
	Total	**Food**	**Gini**	**10th**	**25th**	**50th**	**75th**	**90th**
PANEL A								
Ebola	-0.0477***	-0.0512***	-0.0172***	0.0227	-0.0351*	-0.0388**	-0.0315	-0.0996***
	(0.0143)	(0.0143)	(0.00567)	(0.0494)	(0.0199)	(0.0171)	(0.0208)	(0.0179)
Observations	6738	6738	6738	6738	6738	6738	6738	6738
R-squared	0.465	0.484	0.081	0.487	0.485	0.397	0.358	0.465
PANEL B								
Quarantine	-0.120***	-0.135***	-0.0469***	0.00290	-0.139***	-0.0522***	-0.197***	-0.288***
	(0.0128)	(0.0130)	(0.00554)	(0.0449)	(0.0186)	(0.0170)	(0.0186)	(0.0162)
Observations	6738	6738	6738	6738	6738	6738	6738	6738
R-squared	0.471	0.492	0.089	0.116	0.262	0.395	0.372	0.292

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
The regression models include control variables for household characteristics like head's age, gender, education, employment, religion, and marital status. Additionally, the control variables include settlement areas, household facilities like electricity access, durable assets, and the number of rooms occupied. Agricultural land access and indices of household dwelling and amenities form part of the regression controls.

The foregoing examined the impact of the Ebola virus and the government's quarantine policy on objective poverty measures based on expenditure-based poverty lines. Our attention now turns to an evaluation of the impact of Ebola on household expenditure itself and its distribution (equation 4.2, 4.8 and 4.9 respectively). This will provide empirical insights into where along the unconditional household expenditure distribution the Ebola outbreak and the government policy responses had their strongest effects. Table 4.7 presents the result on household expenditure for both interventions (Ebola and Quarantine) in panels A and B, respectively. Again, the first three columns of Table 4.7 contain the estimates of mean household expenditure and the Gini coefficient analysis. The estimated unconditional quantile effects are presented in the last five columns of this table. In Panel A of Table 4.7, households in chiefdoms with confirmed cases of Ebola exhibit a reduction in both household expenditure and its inequality. Total and food household expenditure decreased by 4.7% and 5.1%,

respectively, on average and *ceteris paribus*. In contrast, inequality as measured by the Gini coefficient decreased by 1.7 percentage points, on average and *ceteris paribus*.

The last five columns report the effects of chiefdoms having confirmed Ebola cases on the distribution of household expenditure at different quantiles of the unconditional distribution. The effect shows a gradual but steady reduction in expenditure from the bottom to the top selected quantiles. Households located at the bottom quantiles of the distribution do not report significant changes in their expenditure patterns in response to the presence of Ebola cases. However, the median expenditure level sees a 3.9% reduction. This negative impact is of greater magnitude for households located at the top percentile of the unconditional log household expenditure distribution, with a 10% reduction in household expenditure detected for the Ebola-affected chiefdoms at the 90^{th} percentile of the distribution. Overall, the data reveal a reduction in household expenditure inequality of about 1.7 percentage points as measured by the Gini.

Our attention now turns to examining the effects on household expenditure (both total and food) of the government quarantine policy. The results of this analysis are also presented in Panel B of Table 4.7 above. The quarantine policy has a strong negative impact on household expenditure, the Gini coefficient, and across the top end of the unconditional log household expenditure distribution. Households in a chiefdom subjected to the quarantine policy incurred a 12% and 13.5% reduction in total and food household expenditures, respectively. The household inequality index (Gini coefficient) reduces by 4.7 percentage points on average. However, the households at the bottom end of the expenditure distribution do not incur any significant changes in their expenditure levels. Conversely, the effect is stronger and negative as we move up the household expenditure distribution. Households located at the 25^{th} percentile

incur about a 14% reduction in their expenditures. The quarantine impact softens at the median level, but the negative impact intensifies for the 75th and 90th percentiles, at which households experience 19.7% and 28.8% reductions in their expenditures, respectively, *ceteris paribus*. This set of results suggest a greater adverse impact of the quarantine policy on household expenditure and its distribution than that associated with the presence of Ebola cases in the household chiefdom area. On the basis of the raw differences reported in Table 4.2, the compelling differences are not explained by differentials in household control variables across the two groups separated by the quarantine policy.

The above results provide a descriptive understanding of the association between household welfare and exposure to the two Ebola-related treatment measures (the presence of cases and the government quarantine policy). Therefore, the subsequent analysis attempts to provide a causal estimate of the Ebola outbreak in Sierra Leone on household welfare indicators using PSM. The treatment assignment logit equation estimation results for both Ebola cases and the quarantine measures are presented in Table A4.4 in the appendix. In addition, Tables A4.5 to A4.7 in the appendix document (and confirm) how the balancing properties are satisfied in both cases.

Table 4.8 reports the PSM estimates. The treatment effect of households in chiefdoms that reported confirmed cases of Ebola reveals a significant 3.8 percentage point reduction in food poverty but no change in total poverty. The impact on household expenditure is not significant but suggests a levelling effect on household inequality (as measured by the Gini coefficient). The treatment effect of Ebola on the Gini coefficient, using Chiefdom-level confirmed cases, implies a 2.9 percentage point reduction in household expenditure inequality, on average.

Table 4.8: PSM Average Treatment Effect of Ebola and Quarantine on Welfare Indicators (2018)

	Ebola	**Quarantine**
Poor	-0.0100	0.1170***
	(0.0150)	(0.0123)
Food	0.0376***	0.1673***
	(0.0150)	(0.0123)
Log per capita total expenditure	0.0237	-0.0638***
	(0.0196)	(0.0167)
Log per capita total food expenditure	0.0222	-0.0766***
	(0.0202)	(0.0171)
Expenditure Gini	-0.0287***	-0.0287***
	(0.0084)	(0.0063)
Samples: Treatment	**3339**	**2956**
Control	**3399**	**3782**

Bootstrap standard errors with 500 reps in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

The results on the treatment effect of the government quarantine policy suggest a stronger effect on household welfare in comparison to that associated with those chiefdoms with confirmed Ebola cases. Household objective poverty increases for those in the quarantined areas by 11.7 percentage points on average. Households below the food poverty line increased significantly by 16.7 percentage points for those subjected to the Ebola quarantine measures. The impact on objective poverty already noted is further reflected through reductions in total and food household expenditures of 6.4% and 7.7 %, respectively, on average and *ceteris paribus*.

The strong quarantine-based effect is not observed for chiefdoms that reported confirmed cases of Ebola. This suggests that quarantine policies during the Ebola epidemic had a sharper adverse impact on household welfare. However, it is worth noting that the inequality impact for the quarantined chiefdoms is of the same magnitude as that for the chiefdoms with confirmed Ebola cases. Both treatment effects reveal a reduction in household expenditure inequality of about 2.9 Gini (percentage) points.

The quarantine policy effects represent the preferred estimates informing the policy implications of the Ebola outbreak on household welfare in Sierra Leone. The national quarantine exacerbated this strong negative effect as the curtailment policies imposed stringent economic and social restrictions. The presence of Ebola cases represents an individual direct impact that has low potential to reduce economic activities on a broader scale in contrast to the quarantine policies. Government supporting activities in terms of food provision for individual households with Ebola victims may have mitigated the national quarantine's more substantial impact. However, the national quarantine policy disturbed any potential for welfare smoothing, hence its stronger negative impacts on household welfare.

The above results potentially reveal the causal impacts of the Ebola crisis in Sierra Leone on objective poverty, household expenditure, and inequality. To provide a more concrete causal interpretation of the results, pre-Ebola estimates of the selected welfare indicators are presented in Table 4.9 for 2011 with difference-in-difference estimates for quarantine policy provided in the last column. The 2011 estimates are computed using the same estimation technique as the main results using the 2018 data. Propensity score matching enables the calculation of the average treatment effect but is limited in capturing the role of unobservable differences between the Ebola and non-Ebola chiefdoms. Hence, the difference-in-difference estimation provides a solution to mitigate the effect of time-invariant unobservable differences between the treatment and control groups. As noted in the contextualisation and the description section, there was a legacy of household poverty in the Ebola-quarantined chiefdoms before the outbreak. Hence, the Ebola-quarantined chiefdoms may have some unobserved characteristics that make them susceptible to disease outbreak.

Table 4.9: PSM Average Treatment Effect and Difference-in-Difference Estimate of Ebola and Quarantine on Welfare Indicators

	2011		2018		D-i-D
	Ebola	**Quarantine**	**Ebola**	**Quarantine**	**Quarantine**
Poor	0.06035***	0.0610***	-0.0100	0.1170***	0.056***
	(0.0163)	(0.0140)	(0.0150)	(0.0123)	(0.0186)
Food	0.0342***	0.0562***	0.0376***	0.1673***	0.1111***
	(0.0158)	(0.0140)	(0.0150)	(0.0123)	(0.0189)
Log per capita total expenditure	-0.0693***	-0.0430	0.0237	-0.0638***	-0.0208
	(0.0280)	(0.0243)	(0.0196)	(0.0167)	(0.0294)
Log per capita total food expenditure	-0.0565***	-0.0369**	0.0222	-0.0766***	-0.0397**
	(0.0196)	(0.0170)	(0.0202)	(0.0171)	(0.2411)
Expenditure Gini	0.0043***	0.0234***	-0.0287***	-0.0287***	-0.0521***
	(0.0093)	(0.0070)	(0.0084)	(0.0063)	(0.0109)
Samples: Treatment	**4177**	**3100**	**3339**	**2956**	
Control	**2507**	**3568**	**3399**	**3782**	

Note: The estimates are the average treatment effect of chiefdoms simulated to have confirmed Ebola cases and the quarantine policy treatment measure. The results are computed using the 2011 SLIHS data, which was collected three years before the Ebola outbreak in Sierra Leone.
D-I-D denotes the difference-in-difference between pre- and post-Ebola quarantine measures to inform on causality.
Bootstrap standard errors with 500 reps in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

On average, Sierra Leone's pre-Ebola conditions portray a legacy of poverty (in terms of both total and food poverty). Households in the quarantined regions had a higher level of poverty by 6 percentage points than those in the non-quarantined chiefdoms before the Ebola outbreak. However, the poverty status was made worse by the national quarantine policy, yielding a 5.6 percentage point increase. Food poverty increased significantly, with a difference-in-difference estimate revealing an 11.1 percentage point increase, on average and *ceteris paribus*. Also, household expenditure exhibited a marginal decrease due to the quarantine policy, but the level of inequality contracted by 5.2 Gini percentage points. The results in Table 4.9 provide further evidence that our main estimates are potentially causal in nature.

We now explore the impact of the Ebola outbreak (cases and quarantine) on subjective household welfare measures. Table 4.10 presents the results for subjective welfare using both the probit regression model (equation 4.10) and the PSM technique. The first section provides

the four sets of results relating to the confirmed Ebola cases and the quarantine measures. The second section presents the average treatment effect on household subjective welfare. The first two columns relate to the Ebola cases measure. The last two columns provide the results for the government quarantine policy.

In panel 1, column 1, households in chiefdoms with confirmed Ebola cases register a negative poverty status effect relative to their neighbours. Subjective poverty increased by 12.5 percentage points for households in chiefdoms with confirmed Ebola cases. The estimated effect is similar in magnitude for households in quarantined chiefdoms (see column 3). In some sense, this confirms the utility of subjective measures in informing on poverty incidence, as the estimates are broadly comparable to those obtained using the objective measures. The government policy of quarantining chiefdoms to curtail the Ebola outbreak led to households judging their welfare less favourably relative to their neighbours. The subjective poverty impact is comparable across the two treatments.

Table 4.10: Probit Impact Effects and PSM ATT for Subjective and Food Poverty (2018)

	EBOLA		**QUARANTINE**	
Panel 1	Subjective Poor	Food Insecurity	Subjective Poor	Food Insecurity
Probit	0.1245***	-0.0074	0.1188***	0.0204
	(0.0155)	(0.0142)	(0.0138)	(0.0133)
Pseudo R^2	0.1648	0.0352	0.1648	0.0354
Observations	**6213**	**6228**	**6228**	**6228**
Household Controls	**Yes**	**Yes**	**Yes**	**Yes**
Panel 2				
PSM ATT	0.1175***	0.01447	0.1082***	0.0277**
	(0.0149)	(0.0152)	(0.0126)	(0.0132)
Observations				
Treatment	**3336**	**3336**	**2691**	**2691**
Control	**3387**	**3387**	**3537**	**3537**

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
In panel 1, the regression estimation control variables are household characteristics like head's age, gender, education, employment, religion, and marital status. Additionally, the control variables include settlement areas, household facilities like electricity access, durable assets, and the number of rooms occupied. Agricultural land access and indices of household dwelling and amenities form part of the regression controls.

The next part of the analysis examines the impact of the Ebola outbreak on household food security based on household-reported difficulties in satisfying their daily food needs in the previous 12 months. As noted above, we construct a dummy variable taking the value of 1 if households assessed themselves as having difficulties in meeting their daily food needs either 'always' or 'sometimes', and 0 otherwise. The treatment variables of interest, both confirmed Ebola cases and quarantined chiefdoms, appear to exert no significant impact in pushing households into food insecurity.

Our attention now turns to the average treatment effects (ATTs) of Ebola (both cases and quarantine policy) on household subjective poverty and food security. The bottom panel of Table 4.10 above presents the PSM ATT estimates. Columns 1 and 3 in the lower panel present the results for subjective poverty for the Ebola cases and the government quarantine treatments, respectively. On average, *ceteris paribus,* the Ebola outbreak yielded a statistically significant 11 percentage-point increase in household subjective poverty for those households in chiefdoms that reported confirmed cases. The magnitude is similar for households in the quarantined chiefdoms. Again, households in chiefdoms that reported confirmed Ebola cases do not incur a significant impact on their food security. However, the average treatment effect for households in the quarantined chiefdoms reveals an increase in subjective food insecurity of 2.8 percentage points. The curtailment policy clearly exerted a negative impact on household subjective poverty and the ability of households to meet their daily food needs. Given that the analysis uses data collected almost two years after the end of the Ebola outbreak, the quarantine policy appears to have a lingering impact on household subjective poverty.

4.8 Discussion and Policy Implications

The Ebola outbreak represents an additional adverse socio-economic shock for the Sierra Leone economy after the end of the 10-years civil war. Hence, its effect on household welfare is potentially significant. Prior to the outbreak, the health system in Sierra Leone was among one of the poorest-resourced globally according to international rankings. The doctor-patient ratio was deficient, with 136 doctors for a population of six million (0.2 per 1,000) in 2015 (World Health Organisation, 2016). Preceding the Ebola outbreak, the country had about 17 government (or publicly run) hospitals, with a higher number of less well-equipped health clinics around the country. The Ebola outbreak exposed the vulnerability of the country's inherently weak and poorly managed public health system. The eastern area was particularly badly affected by Ebola. The treatment centres were overstretched in these areas, and isolation and quarantine measures were the only feasible solution given no vaccine or therapeutic treatment for the virus was available at that time (Coltart et al., 2017).

The foregoing results suggest that the Ebola outbreak in Sierra Leone had a causal impact on a set of household welfare indicators across a number of dimensions. The findings establish that there was a legacy of disadvantage between the treatment and control groups prior to the Ebola outbreak and the levels deteriorated as a result of the outbreak (see the difference-in-difference estimates in Table 4.9). This is in agreement with existing micro-level studies, which generally find negative impact of epidemics on household livelihoods (Chapoto and Jayne, 2008; Nabyonga-Orem et al., 2008). On average, the epidemic outbreak in 2014 resulted in welfare hardship and reduced inequality even after two years of being Ebola free. Thus, the anticipation of a V-shaped recovery is not entirely vindicated by these data. In general terms, the impact of the Ebola outbreak was to reduce household expenditure, increase objective and subjective household poverty, and decrease inequality. However, the effect on household food security

was not unambiguously negative and, in some cases, yielded no statistically significant effect at all.

The analysis reported here suggests that the government quarantine policy potentially had a sharper and deeper impact on household welfare in terms of poverty and the household expenditure distribution than did the presence of the disease itself at the chiefdom level. The harsh impact of the quarantine policy can be linked to an underresourced pre-Ebola health system, implementation and management of the quarantine measures, and the embedded geographical and institutional make-up of the set of quarantined chiefdoms. The impact of the disease and the curtailment policy responses on food poverty was negative and more significant for objective poverty, as measured by the poverty line, compared to what was found using a subjective household assessment metric. However, households did not experience difficulties in satisfying their food needs under either of the two Ebola treatment measures. Nevertheless, food poverty increased, and the magnitude was significantly higher using the quarantine treatment measure. Household inequality reduced by approximately the same amount using both measures.

Overall, the Ebola curtailment policies disrupted economic activity and had a harsh impact on the socio-economic household welfare indicators for Sierra Leone. The 6.4% estimated reduction in total household expenditure two years after the end of the crisis is substantial, as household expenditures comprise the overwhelming share of Sierra Leone's GDP (Statistics Sierra Leone, 2020).[17] The magnitude of this estimate is comparable with the macro-level

[17] The impact of the iron ore price collapse that led to the closure of two significant mining companies is unrelated to the effect of the quarantine measures. Additional analysis, not presented here, revealed no impact on our estimates when both Biriwa and Marampa chiefdoms were dropped from the analysis. These chiefdoms were the hubs of activity for the London Mining and Africa Minerals mining companies. Hence, the empirical results reported here are not driven by these two closures.

findings reported for the effect of the EVD on GDP growth post-Ebola. Although restrictive policies led to reductions in household welfare as measured both in objective and subjective terms, the incidence of reported food insecurity was low. This might have resulted from the government's support in providing household essentials and food for those in quarantined areas and at other medical treatment centres. Sierra Leone is an economy that depends on the importation of staple foods like rice and other basic foods, and this might have mitigated the negative impact of the Ebola outbreak on the population's food security. Therefore, this factor may have influenced the self-reported lack of difficulty experienced by households in meeting food needs in the aftermath of the Ebola crisis.

The closure of the borders to international travel was also part of the containment policies. The Sierra Leone government established a national task force in March 2014 given knowledge of the virus in neighbouring Guinea and in anticipation of its spread across the border. The strategy included sensitisation and awareness about the virus, training of laboratory technicians and health care workers, and border surveillance. A descriptive analysis from relevant stakeholders' interviews revealed that these efforts were not practical, and coordination was poor (Ross, 2017). Although the practice of curtailment helped to stop the transmission of the disease, the restrictive policies introduced provided the central mechanisms through which the epidemic impacted socio-economic indicators.

The lack of co-ordination between the ministry of health and other international organisations also worsened the negative consequences of the Ebola outbreak. The international response was slow, and failure to appreciate the severity of the virus invited difficulties for the country in combating the outbreak. A climate of denial of the scale of the potential problem in conjunction with traditional cultural practices did not help the situation (Coltart et al., 2017).

The inadequate pre-Ebola response undermined the health sector's capacity to cope with the virus outbreak. In addition, the mobilisation and management of the outbreak were generally chaotic and affected by operational failures. As discussed by Ross (2017), the declaration of a state of emergency following the episode of failed pre-responses and information on the virus severity disturbed the management process. More drastic measures were then required as a result of failing to provide adequate coping measures in advance.

The resultant impact of the Ebola outbreak on household welfare increased poverty, reduced household expenditure and levelled inequality in the manner predicted by the historical work of Scheidel (2017).[18] The levelling of inequality associated with pandemics is also highlighted by Deaton (2021) regarding the impact of the Covid-19 pandemic on individual countries and global inequality. Income inequality has reduced for countries with higher Covid-19 death rates and greater economic restrictions. However, global inequality saw a slight increase because China, a less-rich country, has not lagged behind in productivity because of Covid-19 death compared to rich countries, thus widening the inequality gap globally.

The deployment of measures to halt epidemic or pandemic spread inevitably impacts economic activity in developed countries. The effects are amplified in developing countries by an absence of social welfare safety-nets that protect the more vulnerable households from falling into poverty. The on-going effect of the Covid-19 pandemic on the economic status of developed countries has drawn attention to the role of curtailment policies and their adverse economic consequences. Government policies for controlling the spread of an epidemic are important, but minimising the economic welfare impact of such measures is not an easy task, as many

[18] In 2017, a year after Sierra Leone was declared Ebola-free, the country experienced another devastating natural disaster in the form of a mudslide in a rural mountainous area in the west of the country. This was a year before the SLIHS data, the main data used in this analysis, was collected. In a robustness check on the empirical results, households in this area were dropped from the analysis, but the key findings remained the same.

developed countries have found. The rate of Covid-19 spread in Sierra Leone to date has been among the lowest in the world. The government of Sierra Leone closed the country's borders to international flights immediately after the virus's uncontrolled spread was announced by the World Health Organisation. Sensitisation and the implementation of a curfew between 11pm and 5am to stop social interactions were the main curtailment measures. The virus spread has been controlled without a prolonged national lockdown, suggesting that some lessons have been learned from the EVD event. However, more recent trends have seen an increase in new cases. Nevertheless, the Sierra Leone policy response to Covid-19 appears broadly similar to that adopted for EVD, so it remains to be seen if COVID-19 spreads more aggressively within the country.

It is acknowledged that diseases like HIV/AIDS exert longer-term and more sustained impacts on economic growth and welfare in African countries than the Ebola or related outbreaks do. In general, the potential micro-level impacts are seen in terms of household loss of employment and health-related costs, but for viruses like Ebola these may be more short-term. The impact of Ebola on household welfare appears to be following something closer to a V-shaped rather than a U-shaped recovery, though the impact still persists two years after the epidemic. The results from this research concur with the judgment offered by the macro-economic literature on the adverse effects of diseases like HIV/AIDS on economic activity (see Dixon, McDonald, and Roberts, 2002; Haacker, 2008), with Weil's (2013) research more nuanced in terms of the channel through which the adverse effects are mediated. The rate of HIV/AIDS infection since it first detection in 1987 has been increasing in Sierra Leone. The protracted civil war between 1991-2002 in conjunction with poor health facilities led to a 7% increase in new infections and a 6% increase in related deaths between 2006-2016. This disease and Covid-19 may represent a greater threat to the economic development of Sierra Leone than did the EVD episode.

4.9 Conclusions

This chapter investigated the effects of the Ebola outbreak in Sierra Leone on a series of household-level welfare indicators. The welfare metrics included household poverty (both total and food), household expenditure, and the Gini coefficient (as a measure of household inequality). The analysis further explored the nature of total and food poverty using an internationally acknowledged poverty line, as well as subjective relative assessments of household poverty status. The empirical findings of this study contribute to the limited literature on the impacts of epidemics on household socio-economic status in Sub-Saharan Africa. In the wake of the Ebola outbreak in 2014, Sierra Leone suffered the worst of all West African countries given its weaker institutions and public health infrastructure, and the fact that it was just recovering from a 10-year civil war. Understanding the socio-economic impact of the Ebola outbreak (and related diseases) is of paramount urgency. This research focused on household-level analysis in terms of poverty and inequality rather than political or psychological impacts, which are currently the more prominent themes in the literature on epidemics and pandemics. It is important to note that this is the first study to have evaluated the empirical impact of the Sierra Leone Ebola outbreak on selected household welfare indicators.

In undertaking this research, two treatment measures for the effect of Ebola were created. The first considered households in chiefdoms with recorded confirmed cases of the zoonotic virus. The second considered households subjected to the government quarantine policy. The government quarantine policy yielded a stronger negative effect on household welfare in comparison to that due to households being in chiefdoms with confirmed Ebola cases. The negative impact on poverty is consistent with other micro-level negative impacts of diseases

like HIV/AIDS in Africa reported in the literature (e.g., see Chapoto and Jayne, 2005; Nabyonga-Orem et al, 2008).

The imposition of restrictions on movement impeded economic activity in all sectors, and this translated into impacts on household welfare. Hence, it is clear that curtailment procedures and policies associated with epidemics and pandemics adversely impact household welfare. The estimated Ebola quarantine policy impact can be compared to the civil war impact on average household welfare in Sierra Leone. The civil war was another economy-wide shock experienced by Sierra Leone from 1991-2002. In Essay 1, the estimated annual impact of the civil war was shown to be approximately of the order of a 2.2% reduction in household expenditure. The annual impact of EVD on household welfare reported in this essay is broadly comparable in scale to this effect.

Linking the findings of the Ebola disease impact on household welfare to other diseases like the HIV/AIDS pandemic in Africa emphasises the economic vulnerability of African countries to disease outbreaks (Hacker, 2008). The literature on the HIV/AIDS pandemic predicted an average negative impact on GDP of between 2% to 4% per annum (Dixon et al., 2002). The impact presents a longer-term reduction in overall economic activity and delineates a U-shaped recovery from this persistently present disease. The HIV/AIDS disease is a life-long contraction for which there is currently no vaccine or treatment, and the therapeutical procedures currently used can actually impede individual-level productivity over the long-run. On the other hand, the Ebola outbreak caused a sharp decline in economy-wide productivity due to the curtailment measures adopted. As the survivors may be free of Ebola within weeks, the disease generates a potentially less severe long-term economic loss due to reduced productivity.

An empirical analysis of health shocks can provide a pathway towards understanding how affected countries are vulnerable to such shocks and the economic impact of policies required to combat and control the spread of disease. Data limitations have posed a challenge to studying the socio-economic impacts of health shocks in the past, especially for developing countries. The recent impact of the Covid-19 virus on the economic status of developed countries has drawn attention to the role of curtailment policies and their potentially harsh effects. Government policies in developing countries for controlling the spread of an epidemic should also consider the potential impact on household welfare in contexts where safety nets are non-existent. This is not an easy task, and determining trade-offs is difficult. Nevertheless, early warning systems and policies designed to render health systems more resilient and less vulnerable to the impact of epidemics are desirable objectives for future health planning in developing countries. In addition, an understanding of the economic costs of curtailment/quarantine policies is also required for policy-makers faced with the deadly challenges posed by either an epidemic or a pandemic.

Appendix 3

Figure A 4.1: Ebola Case Patterns by Chiefdom - National Quarantine Measure

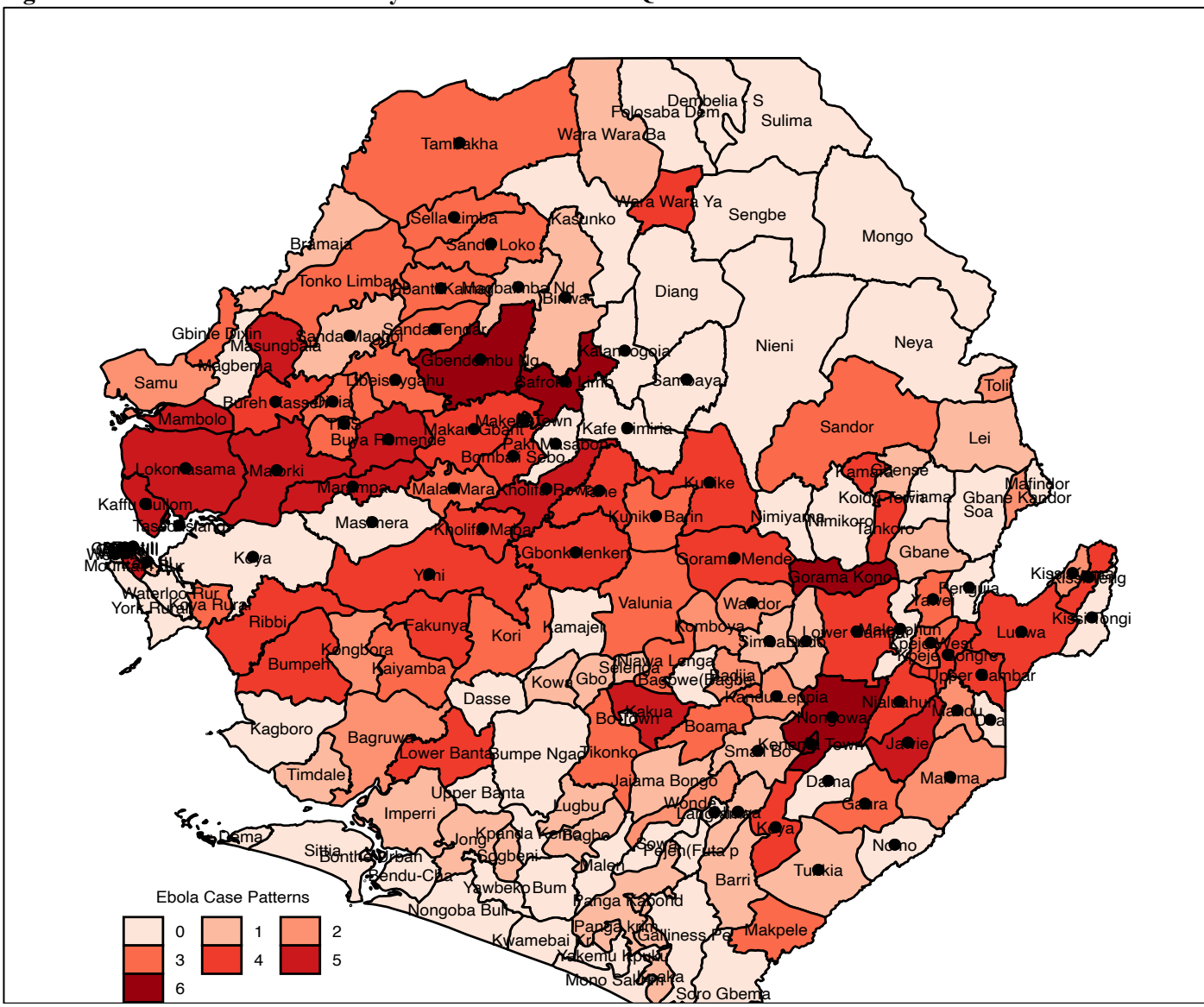


Table A 4.1: Ebola Cases per Chiefdom and per 10,000 of Chiefdom Population (2018)

Chiefdom	No. of cases	District	Chiefdom population	Ebola cases per 10,000 people
Badjia	6	Bo	8042	7.4604
Gbo	4	Bo	5170	7.7367
Jaiama Bo	3	Bo	31021	0.9671
Komboya	7	Bo	15510	4.5131
Niawa Len	19	Bo	13787	13.7810
Selenga	1	Bo	9191	1.0880
Tikonko	29	Bo	52850	5.4872
Valunia	15	Bo	35617	4.2115
Wunde	6	Bo	15510	3.8684
Bagbo	2	Bo	25851	0.7737
Biriwa	17	Bombali	47574	3.5734
Bombali Shebora	582	Bombali	163520	35.5920
Gbanti-Kamaranka	14	Bombali	28666	4.8838
Libeisaygahun	2	Bombali	16468	1.2145
Makari Gbanti	262	Bombali	81730	32.0570
Mambolo	42	Bombali	67091	6.2601
Masungbal	8	Bombali	56113	1.4257
Ngowahun	30	Bombali	39035	7.6854
Paki Masa	59	Bombali	20127	29.3133
Safroko Limba	24	Bombali	31716	7.5672
Sanda Loko	20	Bombali	45134	4.4312
Sella Limba	22	Bombali	58552	3.7573
Tambakka	6	Bombali	38425	1.5615
Baoma	22	Bonthe	15886	13.8484
Bum	48	Bonthe	24028	19.9766
Imperi	1	Bonthe	32964	0.3034
Jong	3	Bonthe	33361	0.8992
Kakua	152	Bonthe	17674	86.0042
Kpanga Kemo	2	Bonthe	10326	1.9368
Sogbini	2	Bonthe	10723	1.8651
Dea	1	Kailahun	13120	0.7622
Jawei	187	Kailahun	50907	36.7335
Kissi Kama	10	Kailahun	20468	4.8857
Kissi Tenge	52	Kailahun	45134	11.5212
Kissi Tonge	15	Kailahun	50907	2.9465
Luawa	49	Kailahun	80822	6.0627
Malema	8	Kailahun	36737	2.1776
Mandu	7	Kailahun	30964	2.2607
Njaluahun	44	Kailahun	60879	7.2275
Peje Bong	49	Kailahun	25191	19.4512
Penguia	1	Kailahun	26241	0.3811
Upper Bambara	65	Kailahun	26766	24.2849
Yawei	21	Kailahun	29390	7.1454
Peje West	15	Kailahun	27290	5.4964
Bramaia	4	Kambia	36836	1.0859
Gbinle-Di	18	Kambia	23631	7.6171
Magbema	115	Kambia	92786	12.3941
Samu	20	Kambia	65333	3.0613
Tonko Lim	34	Kambia	59077	5.7552
Dodo	1	Kenema	22626	0.4420
Gaura	17	Kenema	27307	6.2255
Gorama Me	42	Kenema	50713	8.2819
Kandu Lep	10	Kenema	34329	2.9130
Lower Bambra	38	Kenema	122492	3.1023
Niawa	2	Kenema	13263	1.5079
Nongowa	375	Kenema	281653	13.3143
Simbaru	1	Kenema	28867	0.3464
Small Bo	3	Kenema	49153	0.6103
Tunkia	1	Kenema	33549	0.2981
Wandor	6	Kenema	27307	2.1972
Kasonko	1	Koinadugu	25092	0.3985
Neini	106	Koinadugu	78566	13.4918
Wara Wara	4	Koinadugu	36198	1.1050
Gbane	5	Kono	22156	2.2567

Gbane Kan	1	Kono	6042	1.6549
Gbense	86	Kono	107758	7.9809
Gorama Ko	2	Kono	17624	1.1348
Kamara	29	Kono	18631	15.5655
Lei	1	Kono	24673	0.4053
Maforki	153	Kono	10071	151.9244
Nimikoro	50	Kono	66467	7.5225
Nimiyama	24	Kono	39276	6.1106
Sandor	5	Kono	75027	0.6664
Soa	3	Kono	31723	0.9457
Tankoro	57	Kono	65964	8.6411
Bagruwa	6	Moyamba	27766	2.1609
Bumpeh	16	Moyamba	39574	4.0431
Fakunya	49	Moyamba	27766	17.6477
Kaiyamba	21	Moyamba	25851	8.1236
Kargboro	8	Moyamba	34787	2.2997
Kori	23	Moyamba	30638	7.5070
Kowa	1	Moyamba	9893	1.0108
Ribbi	49	Moyamba	33191	14.7630
Timidale	1	Moyamba	10213	0.9792
Bkm	51	Port Loko	40106	12.7163
Buya Rome	154	Port Loko	34553	44.5695
Dibia	15	Port Loko	15425	9.7243
Kaffu Bul	255	Port Loko	120935	21.0858
Koya	151	Port Loko	23447	64.4019
Lokomasam	137	Port Loko	78361	17.4832
Lugbu	1	Port Loko	86999	0.1149
Marampa	192	Port Loko	59233	32.4142
Masimera	69	Port Loko	40723	16.9438
Sanda Mag	1	Port Loko	24064	0.4156
Sanda Ten	11	Port Loko	26532	4.1460
Tms	25	Port Loko	30851	8.1035
Yoni	81	Port Loko	130807	6.1923
Barri	1	Pujehun	36425	0.2745
Kpaka	1	Pujehun	16340	0.6120
Makpele	21	Pujehun	30638	6.8542
Malen	5	Pujehun	48340	1.0343
Panga Kri	1	Pujehun	8851	1.1298
Gbonkolen	63	Tonkolili	67552	9.3261
Kafe Simi	6	Tonkolili	36702	1.6348
Kholifa	132	Tonkolili	16489	80.0526
Kholifa M	29	Tonkolili	16489	17.5873
Konike Ba	11	Tonkolili	25532	4.3084
Konike Sa	75	Tonkolili	74467	10.0716
Malal Mar	34	Tonkolili	30851	11.0208
Tane	58	Tonkolili	33510	17.3081
Banta Gba	36	Bombali	219572	1.6396
W/Rural	1146	Freetown	446803	25.6489
W/Urban	2274	Freetown	1056725	21.5193
Total population	**8356**		**6287671**	

Table A 4.2: Description of the Household Principal Components and other Input Variables

	Variables	Description
Principal Components	**Housing Characteristics**	This is an index of household dwelling features that can enhance household quality. The dwelling features include flush toilet, latrine with a slab, cemented walls and floor, and zinc roofed homes. Each of the variables are 0/1 dummies. The index is calculated using principal component analysis. The predicted index comes from the first component.
	Amenities Characteristics	This is an index of household accessibility to public amenities. The index is compiled from amenities within a 1hr walking distance. These include transport, hospital, tap or borehole, and market facilities.
Other Input Variables	**Household Characteristics**	These include the following: **Head's age** - a continuous variable for the age of a household head in years. **Household size** - the total number of individuals living in a household **Dependency ratio** - the ratio of dependents (under 18 and over 65) and adults (18-65) in a household **Male head** - a dummy variable taking the value 1 if the head is male and 0 otherwise
	Head's Education	**'No education', 'primary', 'secondary', and 'higher'** are all dummy variables taking the value 1 if a household head's educational level falls in the stated category and 0 otherwise.
	Employment Status	**'Self', 'farm', 'other', and 'unemployed'** are dummy variables taking the value 1 if a household head's employment status falls in the stated category and 0 otherwise.
	Head's Marital Status	**'Married', 'single', 'cohabit', and 'other'** are dummy variables taking the value 1 if a household head's marital status falls in the listed category and 0 otherwise.
	Head's Religion	**'Christian', 'Muslim', and 'other'** are dummy variables taking the value 1 if a household head's religion falls under the stated category and 0 otherwise.
	Urban	A dummy variable taking the value 1 if a household is in an urban area and 0 otherwise.
	Agricultural Land Access	A continuous variable that accounts for the land size in hectares that a household has access to (though not necessarily ownership of).
	Electricity	A dummy variable that takes the value 1 if a household has access to electricity and 0 otherwise.
	Durable Assets	A dummy variable that takes the value 1 if a household has durable assets (radio, furniture, refrigerator, stove, microwave, etc.) and 0 otherwise.
	Rechargeable Light	A dummy variable taking the value 1 if a household uses rechargeable lights at night and 0 otherwise.
	Charcoal Cooking	A dummy variable that takes the value 1 if the household uses a charcoal cooking method and 0 otherwise.

Table A 4.3: Summary Statistics of Household Welfare Indicators by Quarantine Status (2011)

	Overall	Quarantine	Non-Quarantine	Raw Diff
Log of per capita Total Expenditure				
Total	14.0222	13.8792	14.1464	-0.26725***
				(0.0343)
Food	13.6071	13.4990	13.4990	-0.20250***
				(0.0142)
Gini Coefficients: Total	0.3412	0.3402	0.3421	0.0019
				(0.0059)
Food	0.3051	0.3085	0.3022	0.0063
				(0.0061)
Samples	**6668**	**3100**	**3568**	

Note: standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 4.4: Logistic Regression of the Treatment Assignment Equations for Ebola Status-2018

VARIABLES	**Ebola**	**Quarantine**
Head's age	-0.0212*	0.00333
	(0.0116)	(0.0104)
Age sq	0.000184*	3.82e-05
	(0.000111)	(0.000100)
Male head	-0.406***	0.205**
	(0.100)	(0.0847)
Dependency ratio	0.0367	-0.0138
	(0.0285)	(0.0261)
Primary	-0.572***	0.184
	(0.131)	(0.234)
Secondary	0.121	0.00445
	(0.148)	(0.170)
Higher	0.207	-0.241
	(0.398)	(0.238)
Urban	-1.261***	0.405***
	(0.127)	(0.116)
Married head	0.499***	0.371***
	(0.0897)	(0.0948)
Christian head	-0.163	-0.423**
	(0.166)	(0.172)
Housing index	-0.245***	-0.00617
	(0.0404)	(0.0369)
Housing index sq	0.0820***	-0.0538***
	(0.0122)	(0.0122)
Amenities index	-0.00210	-0.0135
	(0.0260)	(0.0240)
Durable assets	0.0699	0.0435
	(0.0793)	(0.0728)
Electricity	0.156	-0.0879
	(0.125)	(0.117)
Rechargeable light	0.481***	-0.0891
	(0.0977)	(0.0924)
Self employed	-0.985***	-0.295***
	(0.0871)	(0.0786)
Charcoal cooking	-0.722***	-0.731***
	(0.0853)	(0.0806)
Male head × urban	0.382***	-0.343***
	(0.135)	(0.119)
Primary × urban	0.159	-0.388***
	(0.178)	(0.121)
Secondary × urban	-0.112	0.129
	(0.177)	(0.102)
Higher × urban	-0.489	-0.162
	(0.412)	(0.113)
Constant	1.237***	-0.233
	(0.315)	(0.279)
Observations	**6723**	**6723**

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A 4.5: Covariates Mean Difference and Variance between Treatment and Control Group (Ebola)-2018

Variable	Treated	Control	%bias	T	p>t	V e(C)
Head's age	47.79	47.36	3.00	1.21	0.23	1.01
Age sq	2502.60	2446.20	3.80	1.54	0.12	1.04
Male head	0.73	0.74	-1.80	-0.72	0.47	1.00
Dependency ratio	1.65	1.64	1.40	0.63	0.53	1.11
Primary	0.10	0.10	-1.40	-0.67	0.50	0.92
Secondary	0.17	0.16	0.90	0.41	0.68	1.01
Higher	0.08	0.09	-2.80	-1.33	0.18	0.92
Urban	0.34	0.34	1.00	0.40	0.69	1.02
Married head	0.16	0.15	2.40	0.92	0.36	1.03
Christian head	0.03	0.03	-0.90	-0.40	0.69	0.95
Housing index	-0.22	-0.21	-1.20	-0.61	0.54	1.02
Housing index sq	1.33	1.29	1.00	0.48	0.64	0.90
Amenities index	0.01	0.04	-2.70	-1.15	0.25	1.09
Durable assets	0.14	0.15	-0.50	-0.18	0.86	1.00
Electricity	0.13	0.13	0.40	0.20	0.84	1.02
Rechargeable light	0.78	0.78	-0.40	-0.18	0.86	1.02
Self employed	0.08	0.08	0.50	0.26	0.80	1.03
Charcoal cooking	0.18	0.18	0.50	0.24	0.81	1.03
Male × urban	0.25	0.25	1.20	0.52	0.60	1.03
Primary × urban	0.04	0.04	1.10	0.62	0.54	1.14
Secondary × urban	0.11	0.10	1.50	0.74	0.46	1.04
Higher × urban	0.07	0.08	-3.00	-1.45	0.15	0.91

* if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2]
** if 'bad', i.e. variance ratio <0.5 or >2

Table A 4.6: Covariates Mean Difference and Variance between Treatment and Control Group (Quarantine)-2018

Variable	Treated	Control	%bias	T	p>t	V e(C)
Head's age	47.95	47.61	2.30	0.89	0.37	0.98
Age sq	2520.50	2468.30	3.50	1.33	0.18	1.03
Male head	0.74	0.74	0.70	0.29	0.78	1.01
Dependency ratio	1.70	1.68	1.80	0.72	0.47	1.14
Primary	0.02	0.01	0.90	0.34	0.73	1.08
Secondary	0.04	0.03	1.40	0.54	0.59	1.08
Higher	0.01	0.01	-1.10	-0.50	0.62	0.90
Urban	0.47	0.45	2.90	1.12	0.26	1.08
Married head	0.15	0.14	2.30	0.85	0.40	1.03
Christian head	0.02	0.02	0.30	0.14	0.89	1.03
Housing index	-0.20	-0.18	-0.80	-0.38	0.70	1.00
Housing index sq	1.20	1.17	0.60	0.33	0.74	1.01
Amenities index	-0.01	0.00	-0.70	-0.29	0.77	1.01
Durable assets	0.14	0.14	0.10	0.03	0.97	1.00
Electricity	0.19	0.19	1.00	0.43	0.66	1.08
Rechargeable light	0.71	0.71	-0.80	-0.33	0.74	1.04
Self employed	0.14	0.13	2.00	0.84	0.40	1.12
Charcoal cooking	0.25	0.25	-0.90	-0.39	0.70	0.94
Male head × urban	0.33	0.32	2.20	0.88	0.38	1.10
Primary × urban	0.06	0.05	2.50	1.17	0.24	1.17
Secondary × urban	0.15	0.15	2.20	0.90	0.37	1.16
Higher × urban	0.09	0.10	-3.90	-1.63	0.10	0.87

* if 'of concern', i.e. variance ratio in [0.5, 0.8) or (1.25, 2]
** if 'bad', i.e. variance ratio <0.5 or >2

Table A 4.7: Balancing Property Diagnostic Check of the Propensity Score-2018

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%concern	%bad
Ebola									
Unmatched	0.17	1607.43	0.00	31.90	24.80	107.2*	0.80	50.00	23.00
Matched	0.00	20.40	0.56	1.50	1.20	11.10	1.22	0.00	0.00
Quarantine									
Unmatched	0.05	456.79	0.00	15.60	11.50	53.5*	0.61	41.00	5.00
Matched	0.00	19.66	0.60	1.60	1.30	11.50	1.24	0.00	0.00

* if B>25%, R outside [0.5; 2]

Table A 4.8: Marginal Effect of Household Poverty Determinants with Ebola status (Full Table)- 2018

	Food Poverty		**Total Poverty**	
Variables	Marginal Estimates	Standard Errors	Marginal Estimates	Standard Errors
Ebola*	0.061***	0.014	0.026	0.015
Head's age	0.008	0.003	0.011	0.003
Head's age sq	0.000	0.000	0.000	0.000
Male head*	0.001	0.016	0.017	0.017
Dependency ratio	0.003	0.020	0.048	0.021
Dependency sq	-0.001	0.003	-0.013	0.004
Primary*	-0.071	0.057	-0.117	0.059
Secondary*	-0.228***	0.040	-0.225***	0.042
High*	-0.193***	0.051	-0.159***	0.055
Urban*	-0.327	0.015	-0.349***	0.015
Muslim*	0.099**	0.040	0.075	0.040
Married*	0.042	0.042	0.046	0.043
Self employed*	-0.101**	0.050	-0.095	0.051
Farm employed*	-0.095	0.038	-0.085	0.040
Housing index	-0.022	0.005	-0.031	0.005
Amenity index	0.010	0.006	0.007	0.006
Durable assets*	-0.010	0.019	-0.012	0.019
Electricity*	-0.158	0.027	-0.143	0.027
Rechargeable light*	-0.058	0.023	0.027	0.023
Land access	0.005	0.006	0.005	0.006

(*) is for discrete change of dummy variable from 0 to 1
*** p<0.01, ** p<0.05, * p<0.1

Table A 4.9: Marginal/Impact Effects of Household Poverty Determinants for Quarantine Status (Full Table)-2018

	Food Poverty		**Total Poverty**	
Variables	Marginal Estimates	Standard Errors	Marginal Estimates	Standard Errors
Quarantine(*)	0.233***	0.013	0.200***	0.014
Head's age	0.009	0.003	0.010	0.003
Head's age sq	0.000	0.000	0.000	0.000
Male head(*)	-0.005	0.016	0.014	0.017
Dependency ratio	0.010	0.020	0.052	0.020
Dependency sq	-0.002	0.003	-0.013	0.004
Primary(*)	-0.064	0.059	-0.113***	0.061
Secondary(*)	-0.238***	0.041	-0.237***	0.042
High(*)	-0.165***	0.053	-0.134***	0.056
Urban(*)	-0.339***	0.015	-0.351***	0.015
Muslim(*)	0.097	0.041	0.071	0.041
Married(*)	0.025	0.044	0.030	0.044
Self employed(*)	-0.092	0.051	-0.079	0.051
Farm employed(*)	-0.085	0.039	-0.078	0.040
Housing index	-0.017	0.005	-0.027	0.005
Amenity index	0.011	0.006	0.007	0.006
Durable assets(*)	-0.011	0.019	-0.012	0.019
Electricity(*)	-0.140***	0.027	-0.125***	0.027
Rechargeable light(*)	-0.048	0.023	0.037	0.023
Land access	-0.004	0.006	-0.003	0.006

(*) is for discrete change of dummy variable from 0 to 1

*** p<0.01, ** p<0.05, * p<0.1

Table A 4.10: Probit Regression Model Estimates on the Determinants of Household Objective Poverty and Food Poverty (Ebola)-2018

VARIABLES	Poor	Food	Poor	Food
Ebola	0.0675*	0.154***	0.0881**	0.153***
	(0.0402)	(0.0358)	(0.0395)	(0.0385)
Head's age	0.0272***	0.0213***	0.0274***	0.0222***
	(0.00648)	(0.00669)	(0.00645)	(0.00633)
Age sq	-0.000207***	-0.000199***	-0.000209***	-0.000209***
	(6.18e-05)	(6.32e-05)	(6.14e-05)	(6.06e-05)
Male head	0.0427	0.00163	0.0390	0.000841
	(0.0445)	(0.0405)	(0.0431)	(0.0409)
Dependency ratio	0.122**	0.00673	0.126**	0.00487
	(0.0534)	(0.0505)	(0.0535)	(0.0504)
Dependency sq	-0.0322***	-0.00265	-0.0330***	-0.00244
	(0.00957)	(0.00843)	(0.00946)	(0.00859)
Primary	-0.294*	-0.177	-0.291*	-0.170
	(0.154)	(0.148)	(0.150)	(0.145)
Secondary	-0.572***	-0.589***	-0.566***	-0.588***
	(0.113)	(0.109)	(0.111)	(0.111)
Higher	-0.401***	-0.494***	-0.398***	-0.494***
	(0.148)	(0.130)	(0.141)	(0.137)
Urban	-0.934***	-0.852***	-0.940***	-0.850***
	(0.0439)	(0.0411)	(0.0439)	(0.0431)
Muslim	0.195*	0.254**	0.190*	0.253**
	(0.106)	(0.103)	(0.108)	(0.104)
Married	0.119	0.105	0.117	0.102
	(0.113)	(0.108)	(0.113)	(0.108)
Self employed	-0.239*	-0.254**	-0.234*	-0.255**
	(0.130)	(0.127)	(0.128)	(0.127)
Farm employed	-0.215**	-0.240**	-0.209**	-0.244**
	(0.103)	(0.0984)	(0.100)	(0.0968)
Housing index	-0.0781***	-0.0542***	-0.0789***	-0.0546***
	(0.0137)	(0.0130)	(0.0135)	(0.0132)
Amenities index	0.0183	0.0252	0.0181	0.0250
	(0.0166)	(0.0159)	(0.0164)	(0.0160)
Durable assets	-0.0304	-0.0259	-0.0314	-0.0255
	(0.0498)	(0.0475)	(0.0492)	(0.0482)
Electricity	-0.363***	-0.399***	-0.363***	-0.402***
	(0.0677)	(0.0676)	(0.0693)	(0.0680)
Rechargeable light	0.0700	-0.146**	0.0729	-0.147**
	(0.0602)	(0.0584)	(0.0589)	(0.0573)
Land access	0.0122	0.0137	0.0128	0.0134
	(0.0149)	(0.0140)	(0.0146)	(0.0143)
Constant	-0.142	0.170	-0.145	0.156
	(0.185)	(0.186)	(0.183)	(0.177)
Pseudo R^2	**0.1956**	**0.1477**	**0.1960**	**0.1481**
Observations	**6738**	**6738**	**6738**	**6738**

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 4.11: Probit Regression Estimates on the Determinants of Household Objective Poverty and Food Poverty (Quarantine)-2018

VARIABLES	**Poor**	**Food**
Quarantine	0.520***	0.598***
	(0.0372)	(0.0361)
Head's age	0.0263***	0.0214***
	(0.00638)	(0.00645)
Age sq	-0.000211***	-0.000214***
	(6.04e-05)	(6.17e-05)
Male head	0.0348	-0.0117
	(0.0421)	(0.0422)
Dependency ratio	0.134***	0.0246
	(0.0510)	(0.0468)
Dependency sq	-0.0334***	-0.00505
	(0.00898)	(0.00793)
Primary	-0.286*	-0.160
	(0.159)	(0.155)
Secondary	-0.605***	-0.618***
	(0.116)	(0.119)
Higher	-0.338**	-0.418***
	(0.153)	(0.142)
Urban	-0.938***	-0.885***
	(0.0418)	(0.0425)
Muslim	0.185*	0.248**
	(0.107)	(0.109)
Married	0.0779	0.0619
	(0.113)	(0.107)
Self employed	-0.200	-0.232*
	(0.140)	(0.132)
Farm employed	-0.196*	-0.213**
	(0.105)	(0.0963)
Housing index	-0.0692***	-0.0435***
	(0.0143)	(0.0133)
Amenities index	0.0189	0.0271
	(0.0165)	(0.0172)
Durable assets	-0.0318	-0.0270
	(0.0525)	(0.0460)
Electricity	-0.318***	-0.352***
	(0.0713)	(0.0646)
Rechargeable light	0.0938	-0.122**
	(0.0588)	(0.0578)
Land access	-0.00844	-0.00976
	(0.0148)	(0.0138)
Constant	-0.296	0.0178
	(0.183)	(0.184)
Pseudo R^2	**0.1793**	**0.2208**
Observations	**6738**	**6738**

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 4.12: OLS Regression on the Determinants of Log Household Expenditure and Gini by Ebola (Full Table) -2018

VARIABLES	Total	Food	Gini	10th	25th	50th	75th	90th
Ebola	-0.0477***	-0.0512***	-0.0172***	0.0227	-0.0351*	-0.0388**	-0.0315	-0.0996***
	(0.0143)	(0.0143)	(0.00567)	(0.0494)	(0.0199)	(0.0171)	(0.0208)	(0.0179)
Head's age	0.0173***	0.0167***	6.90e-05	0.00419	0.0182***	0.0227***	0.0286***	0.0103***
	(0.00230)	(0.00235)	(0.000943)	(0.00734)	(0.00361)	(0.00278)	(0.00338)	(0.00269)
Age sq	-0.001***	-0.00014***	-2.15e-06	1.57e-05	-0.00013***	-0.00022***	-0.00024***	-0.00010***
	(2.26e-05)	(2.28e-05)	(9.43e-06)	(6.78e-05)	(3.55e-05)	(2.57e-05)	(3.26e-05)	(2.56e-05)
Male head	0.104***	0.104***	-0.0279***	0.321***	0.0412*	0.0896***	0.0495**	-0.0413*
	(0.0152)	(0.0164)	(0.00720)	(0.0546)	(0.0220)	(0.0182)	(0.0210)	(0.0213)
Dependency ratio	0.162***	0.161***	-0.00967	0.433***	0.0497**	0.0885***	0.218***	0.166***
	(0.0169)	(0.0183)	(0.00874)	(0.0649)	(0.0246)	(0.0208)	(0.0249)	(0.0374)
Dependency sq	-0.0183***	-0.0184***	0.00505***	-0.0656***	-0.0140***	-0.0128***	-0.0200***	0.000395
	(0.00272)	(0.00291)	(0.00178)	(0.0108)	(0.00389)	(0.00305)	(0.00399)	(0.00728)
Primary	0.0275	0.0290	-0.0819***	0.274	0.184**	0.00376	-0.154**	-0.242***
	(0.0584)	(0.0546)	(0.0246)	(0.214)	(0.0778)	(0.0744)	(0.0781)	(0.0668)
Secondary	0.0701	0.0698	-0.0607***	0.341**	0.189***	-0.0353	-0.0558	-0.147***
	(0.0429)	(0.0448)	(0.0188)	(0.161)	(0.0604)	(0.0533)	(0.0570)	(0.0531)
Higher	0.0722	0.0769	-0.00155	0.0701	0.0865	0.00432	0.132	-0.0137
	(0.0671)	(0.0624)	(0.0338)	(0.207)	(0.0653)	(0.0590)	(0.0840)	(0.0986)
Urban	0.559***	0.602***	-0.118***	0.841***	0.636***	0.718***	0.437***	0.0989***
	(0.0167)	(0.0178)	(0.00704)	(0.0597)	(0.0248)	(0.0221)	(0.0220)	(0.0161)
Muslim	-0.229***	-0.233***	0.0932***	-0.598***	-0.344***	-0.204***	-0.142**	0.0417
	(0.0406)	(0.0413)	(0.0205)	(0.158)	(0.0558)	(0.0487)	(0.0572)	(0.0511)
Married	-0.0487	-0.0517	0.0124	-0.262	-0.0290	0.0367	0.0648	-0.0340
	(0.0460)	(0.0480)	(0.0223)	(0.170)	(0.0588)	(0.0495)	(0.0576)	(0.0533)
Self employed	0.246***	0.252***	-0.0927***	0.737***	0.315***	0.236***	0.251***	-0.144**
	(0.0407)	(0.0426)	(0.0245)	(0.113)	(0.0432)	(0.0530)	(0.0789)	(0.0734)
Farm employed	0.121***	0.127***	-0.0532***	0.452***	0.136**	0.0532	-0.0162	0.00883
	(0.0442)	(0.0465)	(0.0177)	(0.172)	(0.0582)	(0.0457)	(0.0373)	(0.0284)
Housing index	0.0734***	0.0748***	0.0295***	0.0225***	0.0250***	0.0670***	0.126***	0.0465***
	(0.00459)	(0.00467)	(0.00392)	(0.00829)	(0.00430)	(0.00529)	(0.00881)	(0.0114)
Amenities index	-0.0208***	-0.0214***	0.00165	-0.0526***	-0.0209***	-0.00705	-0.0242***	-0.0240***
	(0.00554)	(0.00615)	(0.00276)	(0.0199)	(0.00761)	(0.00757)	(0.00920)	(0.00907)
Durable assets	0.0237	0.0235	-0.000589	0.00876	0.0163	0.0507**	-0.00614	-0.00694
	(0.0174)	(0.0179)	(0.\00932)	(0.0592)	(0.0231)	(0.0229)	(0.0257)	(0.0264)
Electricity	0.330***	0.347***	0.00132	0.583***	0.435***	0.295***	0.268***	0.530***
	(0.0302)	(0.0296)	(0.0118)	(0.0955)	(0.0362)	(0.0324)	(0.0417)	(0.0433)
Rechargeable light	0.0809***	0.0888***	-0.0477***	0.470***	0.377***	0.0215	-0.181***	-0.0647**
	(0.0292)	(0.0289)	(0.00965)	(0.103)	(0.0346)	(0.0285)	(0.0333)	(0.0279)
Land access	0.0106**	0.0102**	0.00543*	0.0270	-0.00374	0.00846	0.0111	0.0211***
	(0.00511)	(0.00510)	(0.00299)	(0.0173)	(0.00740)	(0.00677)	(0.00729)	(0.00797)
Constant	15.48***	14.77***	0.456***	13.92***	15.00***	15.46***	15.82***	16.94***
	(0.0675)	(0.0719)	(0.0287)	(0.223)	(0.0958)	(0.0814)	(0.0968)	(0.0935)
Observations	**6738**	**6738**	**6738**	**6738**	**6738**	**6738**	**6738**	**6738**
R-squared	**0.465**	**0.484**	**0.081**	**0.116**	**0.255**	**0.394**	**0.361**	**0.268**

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 4.13: OLS Regression on the Determinants of Log Household Expenditure, Gini, and Distribution by Quarantine (Full Table)-2018

	Log EXPENDITURE			Log EXPENDITURE PERCENTILES				
	Total	**Food**	**Gini**	**10th**	**25th**	**50th**	**75th**	**90th**
Quarantine	-0.120***	-0.135***	-0.0469***	0.00290	-0.139***	-0.0522***	-0.197***	-0.288***
	(0.0128)	(0.0130)	(0.00554)	(0.0449)	(0.0186)	(0.0170)	(0.0186)	(0.0162)
Head's age	0.0171***	0.0165***	1.16e-05	0.00421	0.0181***	0.0226***	0.0284***	0.00991***
	(0.0023)	(0.0023)	(0.0001)	(0.00787)	(0.00345)	(0.00293)	(0.00322)	(0.00278)
Age sq	-0.0001***	-0.000132***	-8.69e-07	1.57e-05	-0.0001***	-0.0002***	-0.0002***	-9.31e-05***
	(2.24e-05)	(2.27e-05)	(9.53e-06)	(7.31e-05)	(3.38e-05)	(2.70e-05)	(3.12e-05)	(2.66e-05)
Male head	0.106***	0.106***	-0.0274***	0.320***	0.0422**	0.0910***	0.0501**	-0.0382*
	(0.0155)	(0.0156)	(0.00689)	(0.0551)	(0.0206)	(0.0195)	(0.0207)	(0.0214)
Dependency ratio	0.160***	0.160***	-0.0103	0.432***	0.0471**	0.0884***	0.213***	0.161***
	(0.0179)	(0.0179)	(0.00817)	(0.0664)	(0.0238)	(0.0201)	(0.0237)	(0.0327)
Dependency sq	-0.0182***	-0.0183***	0.00511***	-0.0654***	-0.0137***	-0.0129***	-0.0194***	0.000814
	(0.00279)	(0.00280)	(0.00162)	(0.0110)	(0.00372)	(0.00298)	(0.00380)	(0.00626)
Primary	0.0222	0.0231	-0.0839***	0.275	0.179**	0.000824	-0.161**	-0.254***
	(0.0554)	(0.0558)	(0.0251)	(0.209)	(0.0738)	(0.0731)	(0.0794)	(0.0653)
Secondary	0.0667	0.0662	-0.0619***	0.342**	0.187***	-0.0383	-0.0575	-0.153***
	(0.0444)	(0.0447)	(0.0185)	(0.159)	(0.0608)	(0.0541)	(0.0592)	(0.0521)
Higher	0.0530	0.0554	-0.00901	0.0710	0.0648	-0.00437	0.102	-0.0593
	(0.0637)	(0.0639)	(0.0346)	(0.201)	(0.0645)	(0.0630)	(0.0863)	(0.0951)
Urban	0.565***	0.609***	-0.116***	0.834***	0.636***	0.726***	0.432***	0.109***
	(0.0155)	(0.0156)	(0.00681)	(0.0555)	(0.0224)	(0.0219)	(0.0218)	(0.0161)
Muslim	-0.226***	-0.229***	0.0946***	-0.597***	-0.339***	-0.204***	-0.134**	0.0506
	(0.0412)	(0.0416)	(0.0208)	(0.154)	(0.0559)	(0.0490)	(0.0572)	(0.0495)
Married	-0.0389	-0.0406	0.0163	-0.261	-0.0163	0.0396	0.0842	-0.00970
	(0.0470)	(0.0475)	(0.0219)	(0.173)	(0.0599)	(0.0515)	(0.0579)	(0.0517)
Self employed	0.242***	0.246***	-0.0947***	0.732***	0.306***	0.239***	0.232***	-0.158**
	(0.0410)	(0.0414)	(0.0252)	(0.109)	(0.0439)	(0.0535)	(0.0769)	(0.0755)
Farm employed	0.111**	0.116***	-0.0572***	0.452**	0.124**	0.0495	-0.0347	-0.0159
	(0.0433)	(0.0438)	(0.0175)	(0.179)	(0.0580)	(0.0441)	(0.0381)	(0.0299)
Housing index	0.0708***	0.0719***	0.0285***	0.0224***	0.0219***	0.0659***	0.122***	0.0402***
	(0.0045)	(0.00451)	(0.00385)	(0.00851)	(0.00437)	(0.00505)	(0.00867)	(0.0112)
Amenities index	-0.0210***	-0.0216***	0.00157	-0.0526***	-0.0212***	-0.00717	-0.0244***	-0.0245***
	(0.0057)	(0.0057)	(0.0028)	(0.0191)	(0.0077)	(0.0077)	(0.0087)	(0.0088)
Durable assets	0.0237	0.0235	-0.000553	0.00906	0.0166	0.0505**	-0.00543	-0.00664
	(0.0171)	(0.0173)	(0.00929)	(0.0592)	(0.0238)	(0.0228)	(0.0256)	(0.0256)
Electricity	0.318***	0.333***	-0.00339	0.582***	0.421***	0.290***	0.246***	0.501***
	(0.0295)	(0.0298)	(0.0114)	(0.0994)	(0.0353)	(0.0320)	(0.0435)	(0.0431)
Rechargeable light	0.0730***	0.0801***	-0.0506***	0.473***	0.370***	0.0163	-0.189***	-0.0823***
	(0.0280)	(0.0284)	(0.00931)	(0.108)	(0.0354)	(0.0274)	(0.0325)	(0.0283)
Land access	0.0150***	0.0151***	0.00715**	0.0271	0.00149	0.0102	0.0187**	0.0317***
	(0.00505)	(0.00511)	(0.00294)	(0.0173)	(0.00719)	(0.00677)	(0.00744)	(0.00773)
Constant	15.51***	14.81***	0.469***	13.93***	15.04***	15.46***	15.90***	17.02***
	(0.0684)	(0.0692)	(0.0280)	(0.238)	(0.0921)	(0.0802)	(0.0903)	(0.0886)
Observations	**6738**	**6738**	**6738**	**6738**	**6738**	**6738**	**6738**	**6738**
R-squared	**0.471**	**0.492**	**0.089**	**0.116**	**0.262**	**0.395**	**0.372**	**0.292**

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A 4.14: PSM Average Treatment Effect of Ebola and Quarantine on Welfare Indicators (Pre-Ebola - 2011)

	Ebola	**Quarantine**
Poor	0.06035***	0.0610***
	(0.0163)	(0.0140)
Food	0.0342***	0.0562***
	(0.0158)	(0.0140)
Log per capita total expenditure	-0.0693***	-0.0430
	(0.0280)	(0.0243)
Log per capita total food expenditure	-0.0565***	-0.0369**
	(0.0196)	(0.0171)
Expenditure Gini	0.0043***	0.0234***
	(0.0093)	(0.0070)
Samples: Treatment	**4177**	**3100**
Control	**2507**	**3568**

Note: The estimates are the average treatment effect of chiefdoms simulated to have confirmed Ebola cases and the quarantine policy treatment measure. The results are computed using the 2011 SLIHS data, which was collected three years before the Ebola outbreak in Sierra Leone.
Bootstrap standard errors with 500 reps in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

5 Chapter 5-Conclusions and Future Research Suggestions

This thesis has provided an empirical evaluation of the impact of conflict and disease on household welfare and inequality in Sierra Leone. The contextual framework was provided by the 10-year civil war in Sierra Leone between 1991-2002 and the Ebola epidemic outbreak in 2014. The three essays provide an important contribution given the limited nature of micro-level studies on conflict and disease shocks in development economics research.

The first chapter analysed the legacy of the Sierra Leone civil war on average household expenditure and poverty. The estimates suggested that conflict generates a significant negative impact on household expenditure and increases the poverty rate. The rebels' protracted rule and territorial control of chiefdoms in Sierra Leone adversely impacted household welfare conditions in the conflict regions. The infrastructural and institutional destruction associated with this occupation persists even 10 years after the civil war. However, the long-run conflict effects have been mitigated for the victims to some extent by financial support from international aid agencies. However, the economic system, the provision of public goods, and overall governance remain weak and lack resilience.

The second chapter evaluated the conflict's impact on the distribution of household expenditure and inequality. This second essay aimed to go beyond the average impact and detect who were the biggest losers in socio-economic terms from the conflict. The empirical estimates indicated that the 'haves' in society are the ones with the most valuable assets to lose. The loss of these assets during the conflict helped to narrow inequality post-conflict in the short-term. The levelling has its origins in the wealth-targeting behaviour and activities of the rebel groups. The destruction and re-appropriation of wealth assets (instead of a Robin Hood style redistribution) was the hallmark of the Sierra Leone conflict. Households at the top end of the

expenditure distribution were hardest hit because they were in chiefdoms that were under the control of the rebels. This levelling of inequality observed is entirely consistent with the work of the economic historian Walter Scheidel (2017), who has documented the historical role of conflict (and disease) in levelling wealth inequality.

The final chapter of the thesis investigated the impact of the Sierra Leone Ebola outbreak on household welfare, inequality, and food security. Our findings support the adverse impact of epidemics/pandemics on household socio-economic status. We found that the Ebola outbreak in Sierra Leone accounted for reduced household expenditure, increased food poverty and reduced inequality. The effect of household exposure to the disease in terms of confirmed cases in their chiefdoms does not have as adverse an effect as the curtailment policies imposed by the government. The national quarantine policies for chiefdoms due to the epidemic outbreak left a harsher impact on household welfare and exhibited a greater levelling effect on inequality, certainly in the short term.

The table below summarises the empirical estimates to evaluate these two adverse economic shocks on the Sierra Leone economy. Notwithstanding the different empirical methodologies, the estimates broadly reveal the impacts of the 10-year civil war and the Ebola epidemic, respectively.

The annual impact of the civil war on household log expenditure was approximately equivalent to a 3% reduction in household expenditure, which persisted in the long run 10 years after the conclusion of the conflict. Household poverty increased by 16 percentage points, on average, immediately after the civil war. Inequality was levelled by the conflict, with a reduction of 5 percentage points using the Gini. In comparison to the Ebola curtailment policy in 2014, the

per annum reduction in log expenditure two years later was within the conflict impact range. The impact of the Ebola quarantine polices increased poverty by 11 percentage points, and reduced inequality by 2 percentage points using a Gini-based measure. The empirical estimates are consistent with both the micro-level and macro-level research on conflict and disease impact on socio-economic outcomes. In general, the estimates suggest a persistent economic impact for conflict with a U-shaped recovery pattern. Disease impact is seen to exhibit a more (though muted) V-shaped recovery, though the data are not yet fully available for a more long-run interpretation.

Table 5.1: ATT of Conflict and Disease on Household Welfare Indicators in Sierra Leone

Household Welfare Indicators	**Conflict Exposure**		**Ebola (Quarantine)**
	Short-term	**Long-term**	
Log of total expenditure	-0.3331***	-0.2533***	-0.0638***
	(0.1122)	(0.1066)	(0.0167)
Poverty	0.1610***	0.1373***	0.1170***
	(0.0638)	(0.0634)	(0.0123)
Inequality based on the Gini	-0.0552***	0.0049	-0.0287***
	(0.0183)	(0.0081)	(0.0063)

Note: the estimates represented above are the average treatment effects on the selected welfare indicators as presented in Essays 1, 2, and 3. The sample sizes are directly from the different essays for reference.
Conflict exposure is the measure of conflict that captures households in chiefdoms with protracted period of rebel control. Short-term and long-term correspond to the 2003 and 2011 estimates.
Ebola (Quarantine) is the treatment measure that captures the national virus curtailment policy. It represents households in the quarantined chiefdoms.
Bootstrapped standard errors with 250 replications in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

The analysis contained in the thesis provides a novel contribution to understanding the impact of conflict and disease outbreak on household welfare status. First, we noted that policies geared towards reparations for conflict victims could potentially mitigate the negative legacy on household expenditure and poverty. Direct help to foster economic independence or welfare enhancement can be meaningful. However, infrastructural and institutional destruction can be costly and apply a brake to the speed of the future trajectory of the economy. The ultimate policy implication that is new to the research on conflict is that a conflict that directly targets

the wealthy in society ultimately exerts an inequality-levelling effect. This is a relatively novel finding in the literature and supports the analysis reported in Scheidel (2017). The contraction in the distribution of welfare is not necessarily a positive development given the underlying redistribution is not represented by a shift of wealth from the rich to the poor but by either a total destruction of wealth or its appropriation by the rebels for their own personal use. This renders everyone poorer, but the greatest losers are those with conspicuous and tangible assets or valuables.

Second, this thesis offers a unique contribution in its micro-level linking of a disease epidemic to household welfare, poverty, inequality, and food security. The key finding was that disease curtailment policies are the major mechanism through which household livelihoods are ultimately affected.

Although the empirical analysis of the conflict and disease impact on household expenditure, poverty, inequality, and food security was one of the most systematic undertaken for Sierra Leone, there are some limitations. These are emphasised here to outline a set of research suggestions for future work. In the first two chapters, we were unable to empirically estimate the direct impact of the reparation programme established by Sierra Leone's government on household welfare. Data that identify beneficiaries may provide the basis for a clean experimental approach that helps identify the effect of the mitigating policies introduced post-conflict. Unfortunately, no known data were available at the time of the research. Nevertheless, future research along this dimension would help assess the merits and importance of the safety-net mechanisms introduced as part of the post-conflict recovery policies. Specifically, data on labour productivity and earnings of individuals that benefitted from the reparation programmes would have been insightful for the assessment of such policies.

We were also unable to obtain the geo-coordinates of households, which would have provided additional useful information for the empirical analysis. Information on household location during and after the conflict would have provided an enhanced basis for a cleaner identification of those most directly affected by the conflict. Hence, data collection in conflict-affected economies can benefit from geo-coded information for households.

In Essays 1 and 2, and as already noted above, the role of donors and international assistance during and after the conflict was not captured directly. Humanitarian support was significant in Sierra Leone after the conflict. The post-conflict recovery process has been assisted through the joint efforts of national and international organisations. Hence, the impact of these various contributions in the post-conflict recovery process on household welfare for Sierra Leone is worth exploring as part of an agenda for future research.

Essay 3 evaluated the impact of the 2014 Ebola epidemic on Sierra Leone's household welfare. However, the outbreak also affected the other two countries in the Mano River region - Liberia and Guinea. A cross-country micro-level analysis of the impact of Ebola on household welfare indicators could potentially provide a fruitful basis for future research. It could help in evaluating the different state-level policy interventions for a disease that affected different economies concurrently. All three countries used quarantine measures to fight the disease outbreak. Hence a comparative evaluation of the impact might shed light on whether or not the measures exerted a heterogeneous impact. The global Covid-19 pandemic and its effect on the selected household indicators for Sierra Leone could provide lessons on how the country is dealing with the pandemic. Whether or not the government has refined its approach due to the Ebola outbreak is currently an interesting and open research question.

Finally, the disease evaluated in this thesis does not include other important viruses that have affected West Africa and Sierra Leone in particular (e.g., HIV/AIDS and Malaria). Also, research on the recent outbreak of Hepatitis-B in West Africa could provide an understanding of the household welfare impact of this disease. The current Sierra Leone Integrated Household Surveys and the Demographic Health Surveys have information on HIV/AIDS and Malaria which could inform useful research on the impact of disease outbreak on household welfare and inequality. An analysis of other diseases could offer more informed insights on the household welfare–disease nexus, with a focus on longer-term diseases rather than on short-lived but devastating viruses like Ebola.

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